W406-LX
User's Manual

Second Edition, November 2009

www.moxa.com/product

© 2009 Moxa Inc. All rights reserved.
Reproduction without permission is prohibited.

W406-LX
User's Manual

The software described in this manual is furnished under a license agreement and may be used only in accordance with the terms of that agreement.

Copyright Notice

Copyright © 2009 Moxa Inc.
All rights reserved.
Reproduction without permission is prohibited.

Trademarks

MOXA is a registered trademark of Moxa Inc.
All other trademarks or registered marks in this manual belong to their respective manufacturers.

Disclaimer

Information in this document is subject to change without notice and does not represent a commitment on the part of Moxa.

Moxa provides this document "as is," without warranty of any kind, either expressed or implied, including, but not limited to, its particular purpose. Moxa reserves the right to make improvements and/or changes to this manual, or to the products and/or the programs described in this manual, at any time.

Information provided in this manual is intended to be accurate and reliable. However, Moxa assumes no responsibility for its use, or for any infringements on the rights of third parties that may result from its use.

This product might include unintentional technical or typographical errors. Changes are periodically made to the information herein to correct such errors, and these changes are incorporated into new editions of the publication.

Technical Support Contact Information
www.moxa.com/support

Moxa Americas:
Toll-free: 1-888-669-2872
Tel: +1-714-528-6777
Fax: +1-714-528-6778

Moxa China (Shanghai office):
Toll-free: 800-820-5036
Tel: +86-21-5258-9955
Fax: +86-10-6872-3958

Moxa Europe:
Tel: +49-89-3 70 03 99-0
Fax: +49-89-3 70 03 99-99

Moxa Asia-Pacific:
Tel: +886-2-8919-1230
Fax: +886-2-8919-1231

Table of Contents

Chapter 1 Introduction 1-1

Overview 1-2
Software Architecture 1-2
- Journaling Flash File System (JFFS2) 1-3
- Software Package 1-4

Chapter 2 Getting Started 2-1

Powering on the W406-LX 2-2
Connecting the W406-LX to a PC 2-2
- Serial Console Port 2-2
- Acquiring the IP Address of the W406-LX 2-3
- Telnet Console 2-4
- SSH Console 2-5

Configuring the Ethernet Interface 2-6
- Modifying Network Settings with the Serial Console Port 2-6
- Modifying Network Settings by Command 2-7

USB Port for Expansion 2-7
SD Socket for Storage Expansion 2-7
Setting Up the Wireless Module 2-8
Configuring the SIM Card 2-8
Entering the PIN Code 2-8
Verifying the SIM Card Status 2-9
Enabling or Disabling the PIN Code Authentication 2-9
Changing the PIN Code 2-11
Unlocking the SIM Card 2-12
Connecting to the Internet 2-13
Reconnecting to the Internet 2-14
Disconnecting from the Internet 2-14
Detecting an Internet Connection Error 2-15
Sending and Reading an SMS Message 2-16
Deleting an SMS Message 2-17
Test Program—Developing Hello.c 2-17
- Installing the Tool Chain (Linux) 2-18
- Checking the Flash Memory Space 2-18
- Compiling Hello.c 2-19
- Uploading and Running the “Hello” Program 2-19

Chapter 3 Managing Embedded Linux 3-1

System Version Information 3-2
- Upgrading the Firmware 3-2
- Loading Factory Defaults 3-4

Enabling and Disabling Daemons 3-4
Setting the Run-Level 3-6
Adjusting the System Time 3-7
- Setting the Time Manually 3-7
- NTP Client 3-8
- Updating the Time Automatically 3-9

Cron—Daemon to Execute Scheduled Commands 3-9

Chapter 4 Managing Communications 4-1
Telnet / FTP 4-2
DNS 4-2
Web Service—Apache 4-3
Install PHP for Apache Web Server 4-5
IPTABLES 4-6
NAT 4-10
NAT Example 4-11
Enabling NAT at Bootup 4-11
Dial-up Service—PPP 4-12
PPPoE 4-15
NFS (Network File System) 4-18
Setting up the W406-LX as an NFS Client 4-18
Mail 4-18
SNMP 4-19
Package Management—ipkg 4-19
OpenVPN 4-20

Chapter 5 Development Tool Chains 5-1
Linux Tool Chain 5-2
Steps for Installing the Linux Tool Chain 5-2
Compilation for Applications 5-2
On-Line Debugging with GDB 5-3

Chapter 6 Programmer's Guide 6-1
Flash Memory Map 6-2
Device API 6-2
RTC (Real Time Clock) 6-2
Buzzer 6-3
UART 6-3
Digital I/O 6-5
C Library 6-10

Chapter 7 Software Lock 7-1

Appendix A System Commands A-1
Linux normal command utility collection A-1
File manager A-1
Editor A-1
Network A-1
Process A-2
Other A-2
Moxa special utilities A-2

1

Introduction

The W406-LX is an embedded computer that features 2 software selectable RS-232/422/485 ports, 1 Ethernet port, and quad-band GSM/GPRS/EDGE 900/1800/850/1900 MHz for cellular communication. It also comes with an SD socket, USB host, and 4 digital input and 4 digital output channels, making it the ideal computer for a variety of industrial applications such as data acquisition, data processing, protocol conversion, and remote device control and monitoring via wireless communication.

The following topics are covered in this chapter:

- **Overview**
- **Software Architecture**
  - Journaling Flash File System (JFFS2)
  - Software Package

Overview

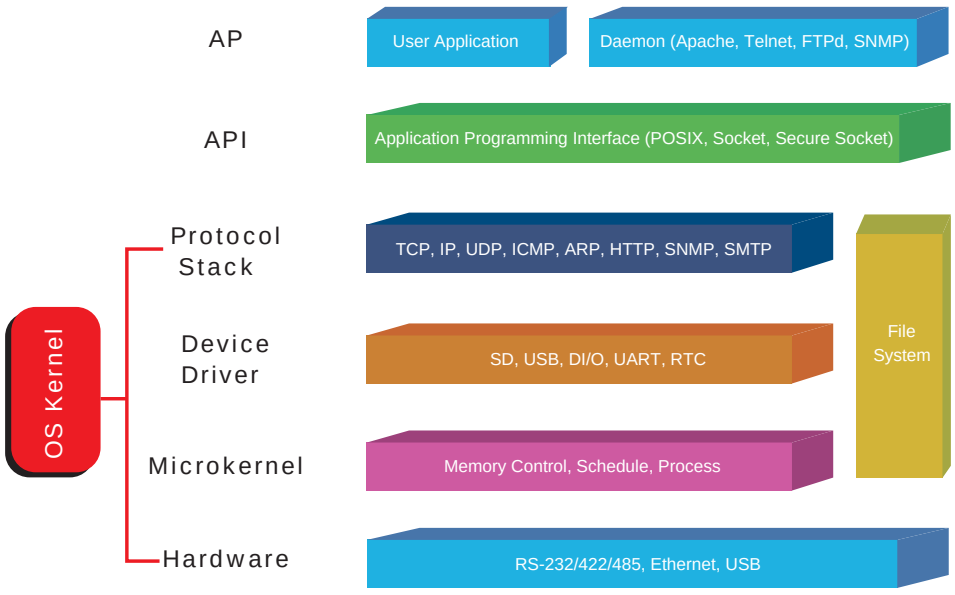
The W406-LX embedded computers, which are designed for industrial automation applications, feature 2 RS-232/422/485 serial ports, 1 Ethernet port, 4 digital input channels, 4 digital output channels, 1 USB 2.0 host and SD socket. The DIN-Rail vertical form factor makes it easy to install the W406 embedded computers in small cabinets. This space-saving feature also facilitates easy wiring, and makes the W406-LX the best choice as front-end embedded controllers for industrial applications.

The W406-LX computers use a Cirrus Logic EP9302 32-bit ARM9 processor. Unlike the X86 CPU, which uses a CISC design, the RISC architecture and modern semiconductor technology provide these embedded computers with a powerful computing engine and communication functions, without generating excessive heat. The quad band GSM/GPRS/EDGE 850/900/1800/1900 wireless module makes the W406 computers the ideal solution when establishing a stable and reliable long-range communication for industrial applications.

The W406-LX's pre-installed Linux operating system (OS) provides an open software operating system for your software program development. Software written for desktop PCs can be easily ported to the computer with a GNU cross compiler, without modifying the source code. The OS, device drivers (e.g., serial and buzzer control), and your own applications, can all be stored in the NOR Flash memory.

Software Architecture

The Linux operating system that is pre-installed on the W406-LX follows the standard Linux architecture, making it easy to accept programs that follow the POSIX standard. Program porting is done with the GNU Tool Chain provided by Moxa. In addition to Standard POSIX APIs, device drivers for the CF storage, buzzer and Network controls, and UART are also included in the Linux OS.



The W406-LX's built-in Flash ROM is partitioned into **Boot Loader**, **Linux Kernel, Root File System**, and **User directory** partitions.

In order to prevent user applications from crashing the Root File System, the W406-LX uses a specially designed **Root File System with Protected Configuration** for emergency use. This **Root File System** comes with serial and Ethernet communication capability for users to load the **Factory Default Image** file. The user directory saves the user's settings and application.

To improve system reliability, the W406-LX has a built-in mechanism that prevents the system from crashing. When the Linux kernel boots up, the kernel will mount the root file system for read-only, and then enable services and daemons. During this time, the kernel will start searching for system configuration parameters via ***rc*** or ***inittab***.

Normally, the kernel uses the Root File System to boot up the system. The Root File System is protected, and cannot be changed by the user. This type of setup creates a "safe" zone.

For more information about the memory map and programming, refer to Chapter 6, Programmer's Guide.

Journaling Flash File System (JFFS2)

The Root File System and User directory in the flash memory is formatted with the **Journaling Flash File System (JFFS2)**. The formatting process places a compressed file system in the flash memory. This operation is transparent to the user.

The Journaling Flash File System (JFFS2), which was developed by Axis Communications in Sweden, puts a file system directly on the flash, instead of emulating a block device. It is designed for use on flash-ROM chips and recognizes the special write requirements of a flash-ROM chip. JFFS2 implements wear-leveling to extend the life of the flash disk, and stores the flash directory structure in the RAM. A log-structured file system is maintained at all times. The system is always consistent, even if it encounters crashes or improper power-downs, and does not require ***fsck*** (file system check) on boot-up.

JFFS2 is the newest version of JFFS. It provides improved wear-leveling and garbage-collection performance, improved RAM footprint and response to system-memory pressure, improved concurrency and support for suspending flash erases, marking of bad sectors with continued use of the remaining good sectors (enhancing the write-life of the devices), native data compression inside the file system design, and support for hard links.

The key features of JFFS2 are:

- Targets the Flash ROM Directly
- Robustness
- Consistency across power failures
- No integrity scan (fsck) is required at boot time after normal or abnormal shutdown
- Explicit wear leveling
- Transparent compression

Although JFFS2 is a journaling file system, this does not preclude the loss of data. The file system will remain in a consistent state across power failures and will always be mountable. However, if the board is powered down during a write then the incomplete write will be rolled back on the next boot, but writes that have already been completed will not be affected.

Additional information about JFFS2 is available at:
http://sources.redhat.com/jffs2/jffs2.pdf
http://developer.axis.com/software/jffs/
http://www.linux-mtd.infradead.org/

Software Package

Boot Loader	Moxa private
Kernel	Linux 2.6.23
Protocol Stack	ARP, PPP, CHAP, PAP, IPv4, ICMP, TCP, UDP, DHCP, FTP, SNMP V1, HTTP, NTP, NFS, SMTP, SSH 1.0/2.0, SSL, Telnet, PPPoE, OpenVPN
File System	JFFS2, NFS, Ext2, Ext3, VFAT/FAT
OS shell command	bash
Busybox	Linux normal command utility collection version 1.10.4
Utilities	
tinylogin	login and user manager utility
telnet	telnet client program
ftp	FTP client program
smtpclient	email utility
scp	Secure file transfer Client Program
Daemons	
pppd	dial in/out over serial port daemon
snmpd	snmpd agent daemon
telnetd	telnet server daemon
inetd	TCP server manager program
ftpd	ftp server daemon
apache	web server daemon
sshd	secure shell server
openvpn	virtual private network
openssl	open SSL
Linux Tool Chain	
Gcc (V 4.2.1)	C/C++ PC Cross Compiler
GDB (V6.8)	Source Level Debug Server
Glibc (V2.2.5)	POSIX standard C library
Software Encryption Lock	
BINEncryptor	Encryption tool for binary files (based on patented Moxa technology)

2

Getting Started

In this chapter, we explain how to connect the W406-LX, how to turn on the power, how to get started programming, and how to use the W406-LX's other functions.

The following topics are covered in this chapter:

- **Powering on the W406-LX**
- **Connecting the W406-LX to a PC**
  - Serial Console Port
  - Acquiring the IP Address of the W406-LX
  - Telnet Console
  - SSH Console
- **Configuring the Ethernet Interface**
  - Modifying Network Settings with the Serial Console Port
  - Modifying Network Settings by Command
- **USB Port for Expansion**
- **SD Socket for Storage Expansion**
- **Setting Up the Wireless Module**
- **Configuring the SIM** Card
- **Entering the PIN Code**
- **Verifying the SIM Card Status**
- **Enabling or Disabling the PIN Code Authentication**
- **Unlocking the SIM Card**
- **Connecting to the Internet**
- **Reconnecting to the Internet**
- **Disconnecting from the Internet**
- **Detecting an Internet Connection Error**
- **Sending and Reading an SMS Message**
- **Test Program—Developing Hello.c**
  - Installing the Tool Chain (Linux)
  - Checking the Flash Memory Space
  - Compiling Hello.c
  - Uploading and Running the "Hello" Program

Powering on the W406-LX

Connect the SG wire to the shielded contact located in the upper left corner of the W406-LX, and then power on the computer by connecting it to the power adaptor. It takes about 60 seconds for the system to boot up. Once the system is ready, the Ready LED will light up.

NOTE After connecting the W406-LX to the power supply, it will take about 60 seconds for the operating system to boot up. The green Ready LED will not turn on until the operating system is ready.

ATTENTION

This product is intended to be supplied by a Listed Power Unit and output marked with "LPS (Limited Power Source)" and rated 12-48 VDC, 1200 mA @12 VDC, 580mA @ 48 VDC (minimum requirements).

Connecting the W406-LX to a PC

There are two ways to connect the W406-LX to a PC: through the serial console port or via Telnet over the network. Or, you can use a monitor connected to the VGA output of the W406-LX to connect directly to the computer.

Serial Console Port

The serial console port gives users a convenient way of connecting to W406-LX. This method is particularly useful when using the computer for the first time. Serial console port is useful for connecting W406-LX, so you do not need to know its IP address in order to connect to the serial console port.

Use the serial console port settings shown below.

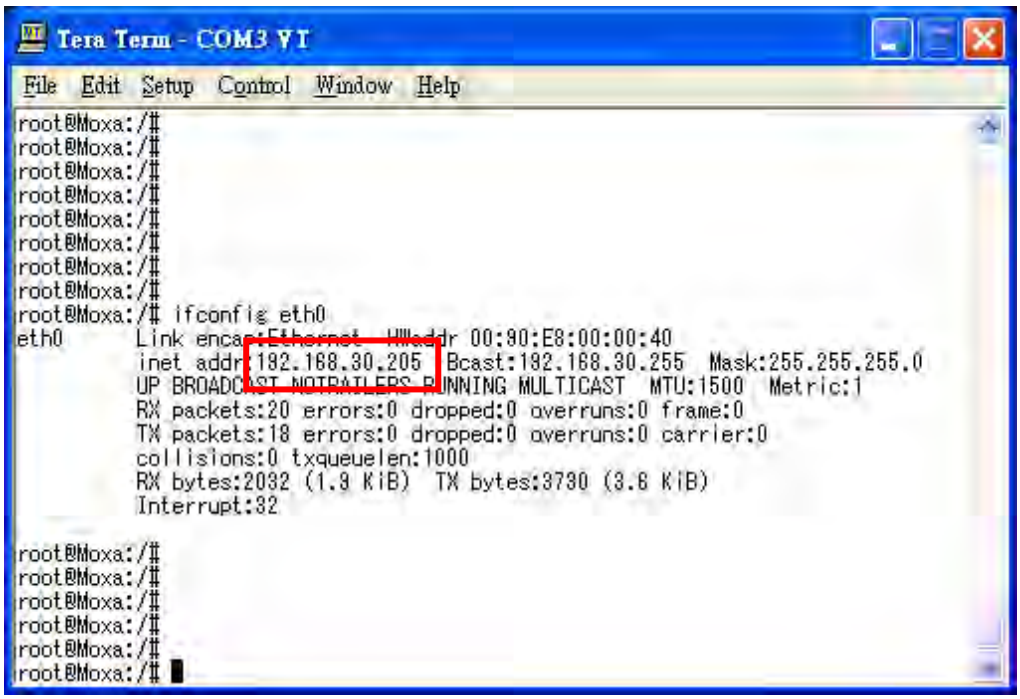
Baudrate	115200 bps
Parity	None
Data bits	8
Stop bits:	1
Flow Control	None
Terminal	VT100

Once the connection is established, the following window will open.

Tera Term - COM3 VT
File Edit Setup Control Window Help
drivers/usb/serial/usb-serial.c: USB Serial Driver core
mice: PS/2 mouse device common for all mice
usbcore: registered new interface driver hiddev
usbcore: registered new interface driver usbhid
drivers/hid/usbhid/hid-core.c: v2.6:USB HID core driver
TCP cubic registered
NET: Registered protocol family 1
NET: Registered protocol family 17
NET: Registered protocol family 15
VFS: Mounted root (jffs2 filesystem) readonly.
Freeing init memory: 88K
INIT: version 2.86 booting
**********SMS daemon **********
scsi 0:0:0:0: Direct-Access Generic STORAGE DEVICE 9412 PQ: 0 ANSI: 0
sd 0:0:0:0: [sda] Attached SCSI removable disk
Disable TCP/IP Explicit Congestion Notification: done.
Configuring network interfaces: done.
Starting internet superserver: inetd.
Starting web server: apache.
Starting portmap daemon:
INIT: Entering runlevel: 3
root@Moxa:/# Starting snmpd
root@Moxa:/#

Acquiring the IP Address of the W406-LX

As the W406-LX uses the DHCP server to acquire the IP address for network connection, please make sure you have the DHCP server ready. When connecting to the W406-LX with serial console port, use **ifconfig eth0** to know the IP address of the W406-LX.



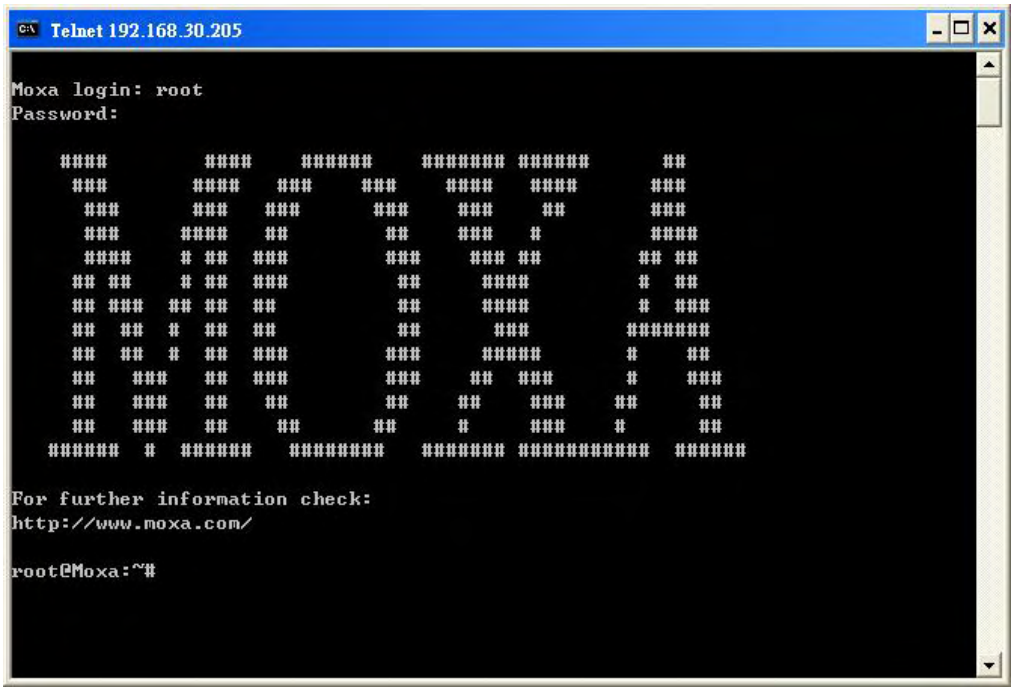
Please note that when you turn on a computer that is not connected to the local network or there is no DHCP server available, it will take about 60 seconds for the system to perform the booting procedure.

Telnet Console

When you know the IP address and netmask, then you can use Telnet to connect to the W406-LX's console utility.

To connect to a hub or switch connected to your local LAN, use a straight-through Ethernet cable. Connect to the IP address, given by the DHCP server, of the W406-LX, and type the login name and password as requested. The default values are both **root**:

```
Login: root
Password: root
```



You can proceed with configuring the network settings of the target computer when you reach the bash command shell. Configuration instructions are given in the next section.

ATTENTION

Serial Console Port Reminder

Remember to choose VT100 as the terminal type. Use the cable CBL-4PINDB9F-100, which comes with the W406-LX, to connect to the serial console port.

Telnet Reminder

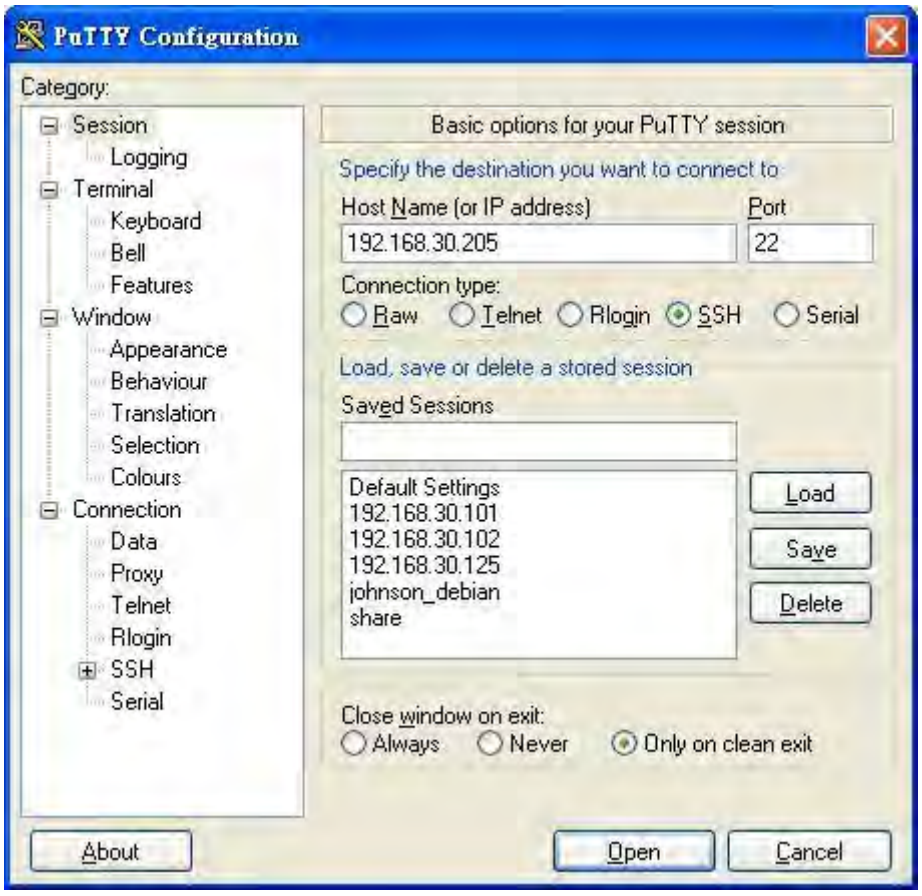
When connecting to the W406-LX over a LAN, you must configure your PC's Ethernet IP address to be on the same subnet as the W406-LX that you wish to contact. If you do not get connected on the first try, re-check the IP settings, and then unplug and re-plug the W406-LX's power cord.

SSH Console

The W406-LX supports an SSH Console to provide users with better security options.

Windows Users

Click on the link http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html to download PuTTY (free software) to set up an SSH console for the W406-LX in a Windows environment. The following figure shows a simple example of the configuration that is required.



Linux Users

From a Linux machine, use the "ssh" command to access the W406-LX's console utility via SSH.

```
#ssh 192.168.30.205
```

Select **yes** to complete the connection.

```
 [root@bee_notebook root]# ssh 192.168.30.205
The authenticity of host '192.168.30.205 (192.168.30.205)' can't be established.
RSA key fingerprint is 8b:ee:ff:84:41:25:fc:cd:2a:f2:92:8f:cb:1f:6b:2f.
Are you sure you want to continue connection (yes/no)? yes_
```

NOTE SSH provides better security compared to Telnet for accessing the W406-LX's console utility over the network.

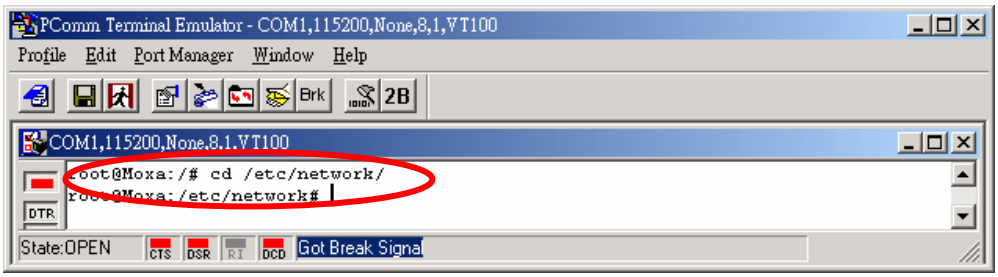
Configuring the Ethernet Interface

The network settings of the W406-LX can be modified with the Debug Port, or online over the network.

Modifying Network Settings with the Serial Console Port

In this section, we use the serial console to configure the network settings of the target computer.

1. Follow the instructions given in a previous section to access the Console Utility of the target computer via the serial console port, and then type **`#cd /etc/network`** to change directories.



2. Type **`#vi interfaces`** to edit the network configuration file with vi editor. You can configure the Ethernet ports of the W406-LX for **static** or **dynamic** (DHCP) IP addresses.

   Dynamic IP Address

   By default, the W406 is configured for dynamic IP addresses. DHCP will assign an IP address for the W406.

   Static IP Address

   You may also manually configure the W406 with a static IP address. Four network addresses must be modified: address, network, netmask, and broadcast.

   See the following table for the example.

Default Setting using DHCP	Static Setting for LAN (example)
Iface etho0 inet dhcp	iface eth0 inet static address 192.168.3.127 network: 192.168.3.0 netmask 255.255.255.0 broadcast 192.168.3.255

3. After the boot settings of the LAN interface have been modified, issue the following command to activate the LAN settings immediately:

   `#/etc/init.d/networking restart`

NOTE After changing the IP settings, use the **networking restart** command to activate the new IP address.

Modifying Network Settings by Command

IP settings can be activated over the command, but the new settings will not be saved to the flash ROM without modifying the file **`/etc/network/interfaces`**.

For example, type the command **`#ifconfig eth0 192.168.1.1`** to change the IP address of LAN to 192.168.1.1.

```
root@Moxa:~# ifconfig eth0 192.168.1.1
root@Moxa:~# _
```

USB Port for Expansion

The W406 has 1 USB 2.0 full speed host (OHCI) that uses a type A connector. The port supports keyboard and mouse, and can also be used to connect a FlashDisk for storing large amounts of data. The USB will be mounted at **/mnt/sda1**. However, it will be mounted at **/mnt/sdb1** when the SD card has been inserted before powering on.

SD Socket for Storage Expansion

The W406 provides a SD socket for storage expansion. Moxa provides a SD flash disk for expansion that allows users to plug in a SD memory card of additional memory space. The SD socket is located on the front panel of the W406. To install a SD card, you must first power off, and then plug the SD card directly into the socket. When finished, power on the W406 computer.

The SD card will be mounted at **/mnt/sda1**.

Please note that the USB and SD card share the same USB hub device. When the system starts, it will detect USB storage first, and then detect the SD card. When both a USB device and SD cared are inserted into the W406, the USB storage device will occupy partition "/dev/sda1", while the SD card will use partition "/dev/sdb1". However, when there is only one of them inserted into the W406 before powering on, the first device will occupy partition "/dev/sda1", and the second device will use partition "/dev/sdb1".

As the W406 does not automatically detect the SD insertion when the system is already on, you need to manually mount the SD card.

When the USB device does not occupy /dev/sda1, use the following command:

#mkdir -p /mnt/sda
#mount /dev/sda1 /mnt/sda

If you want to remove the SD card, use the following command:

#umount /dev/sda1

When the USB device has occupied /dev/sda1, use the following command:

#/mkdir -p /mnt/sdb
#mount /dev/sdb1 /mnt/sdb

If you want to unmount the SD card, use the following command:

#umount /dev/sdb1

Setting Up the Wireless Module

Before using the W406, make sure the SIM card is properly installed and the antenna is connected. (Refer to the W406 Hardware User's Manual for details.) Please note that the SIM card must be installed when the embedded computer is powered off.

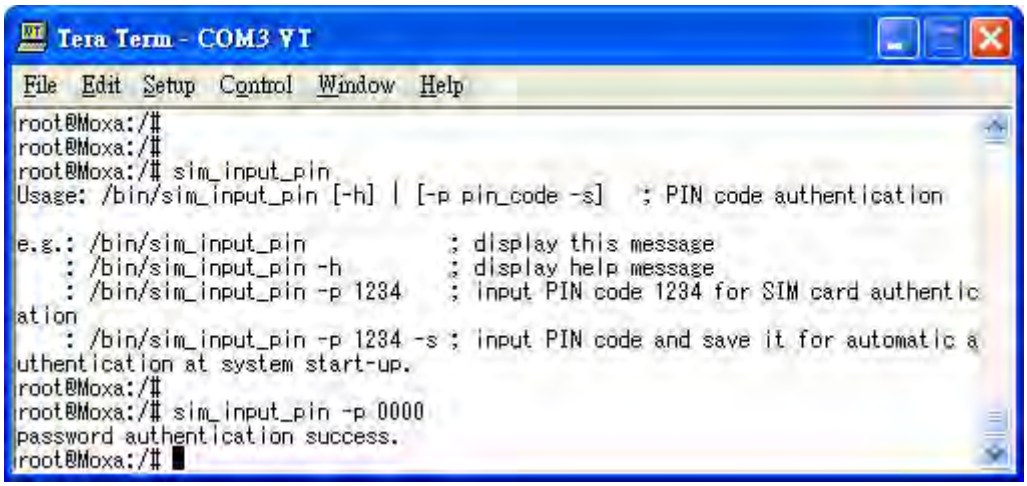
The LED indicators on the front panel can be used to check the signal strength. A background process "egprsagent" is responsible for this task.

Configuring the SIM Card

NOTE: Make sure you have the correct PIN code. After three failed attempts to enter PIN code, the SIM card will be locked, and you will need the PUK code to unlock the SIM card. After ten failed attempts to enter the PUK code, the SIM card will be deactivated and no longer operable.

Entering the PIN Code

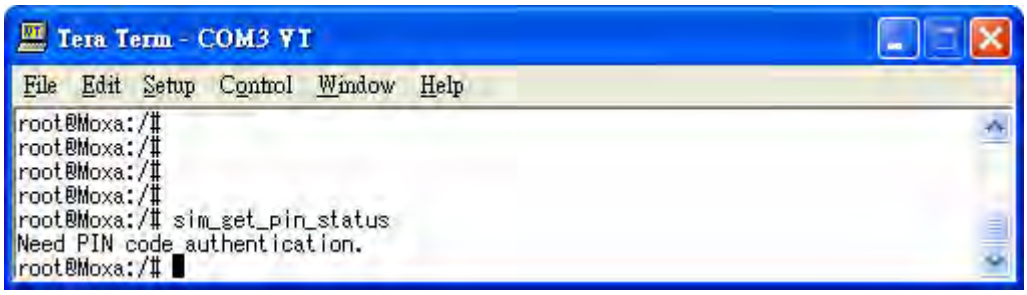
Use the **sim_input_pin –p PIN code** command to enter the PIN code. For example, type **sim_input_pin –p 0000** to enter the PIN code 0000.


Tera Term - COM3 VT
File Edit Setup Control Window Help
root@Moxa:/#
root@Moxa:/#
root@Moxa:/# sim_input_pin
Usage: /bin/sim_input_pin [-h] | [-p pin_code -s] ; PIN code authentication
e.g.: /bin/sim_input_pin ; display this message
: /bin/sim_input_pin -h ; display help message
: /bin/sim_input_pin -p 1234 ; input PIN code 1234 for SIM card authentic
ation
: /bin/sim_input_pin -p 1234 -s ; input PIN code and save it for automatic a
uthentication at system start-up.
root@Moxa:/#
root@Moxa:/# sim_input_pin -p 0000
password authentication success.
root@Moxa:/#

To save the PIN code and perform automatic authentication next time the system boots up, add –s after the PIN code.

Verifying the SIM Card Status

Use the **sim_get_pin_status** command to check the SIM card status.



Four possible responses may appear:

Ready: Your W406 wireless module is ready to work.

No SIM card: You need to insert SIM card into the W406, or your SIM card may not be inserted correctly.

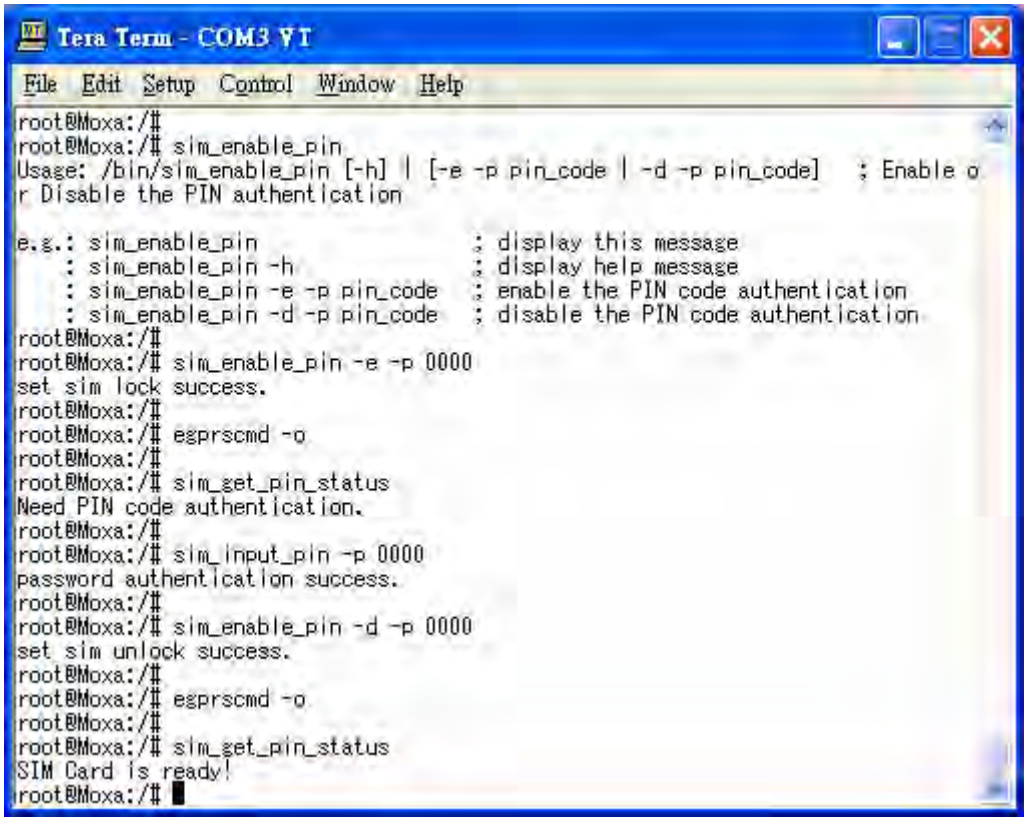
Need PIN code: You need to enter the correct PIN code. See **Entering the PIN code** in this section.

Need PUK code: You need to enter the PUK code: See Unlocking the SIM Card in this section.

Enabling or Disabling the PIN Code Authentication

You can enable PIN code authentication to prompt for PIN code authentication whenever the W406 boots up.

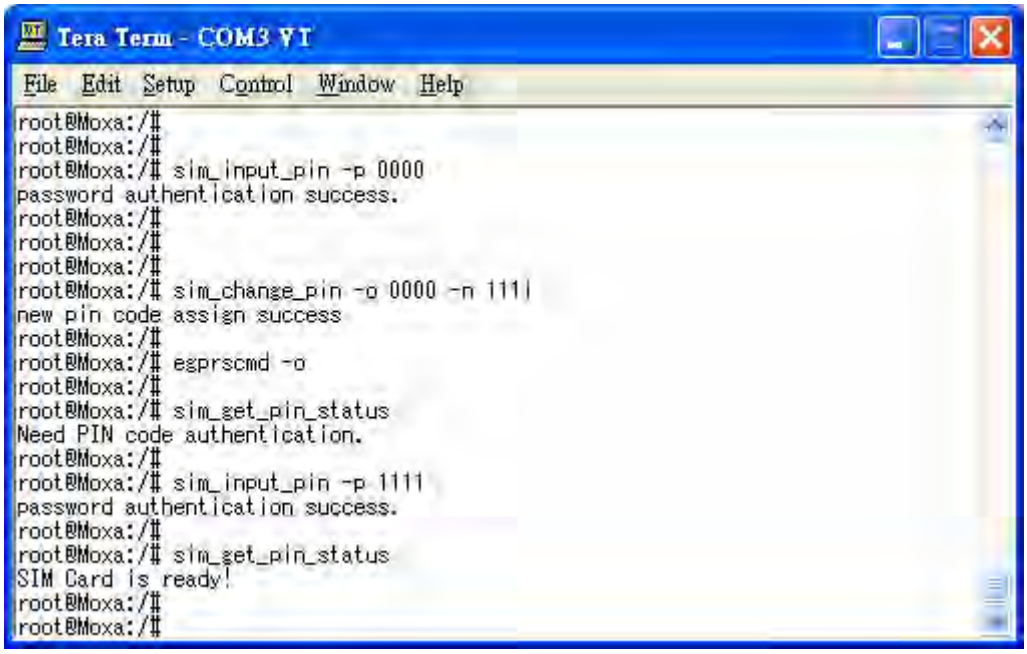
Use the **sim_enable_pin –e –p PIN code** command to enable PIN code authentication. For example, enter **sim_enable_ping –e –p 0000** to activate PIN code authentication.


Tera Term - COM3 VT
File Edit Setup Control Window Help
root@Moxa:/#
root@Moxa:/# sim_enable_pin
Usage: /bin/sim_enable_pin [-h] | [-e -p pin_code | -d -p pin_code] ; Enable o
r Disable the PIN authentication
e.g.: sim_enable_pin ; display this message
: sim_enable_pin -h ; display help message
: sim_enable_pin -e -p pin_code ; enable the PIN code authentication
: sim_enable_pin -d -p pin_code ; disable the PIN code authentication
root@Moxa:/#
root@Moxa:/# sim_enable_pin -e -p 0000
set sim lock success.
root@Moxa:/#
root@Moxa:/# egprscmd -o
root@Moxa:/#
root@Moxa:/# sim_get_pin_status
Need PIN code authentication.
root@Moxa:/#
root@Moxa:/# sim_input_pin -p 0000
password authentication success.
root@Moxa:/#
root@Moxa:/# sim_enable_pin -d -p 0000
set sim unlock success.
root@Moxa:/#
root@Moxa:/# egprscmd -o
root@Moxa:/#
root@Moxa:/# sim_get_pin_status
SIM Card is ready!
root@Moxa:/#

To disable PIN code authentication, use **sim_enable_pin-d –p** command.

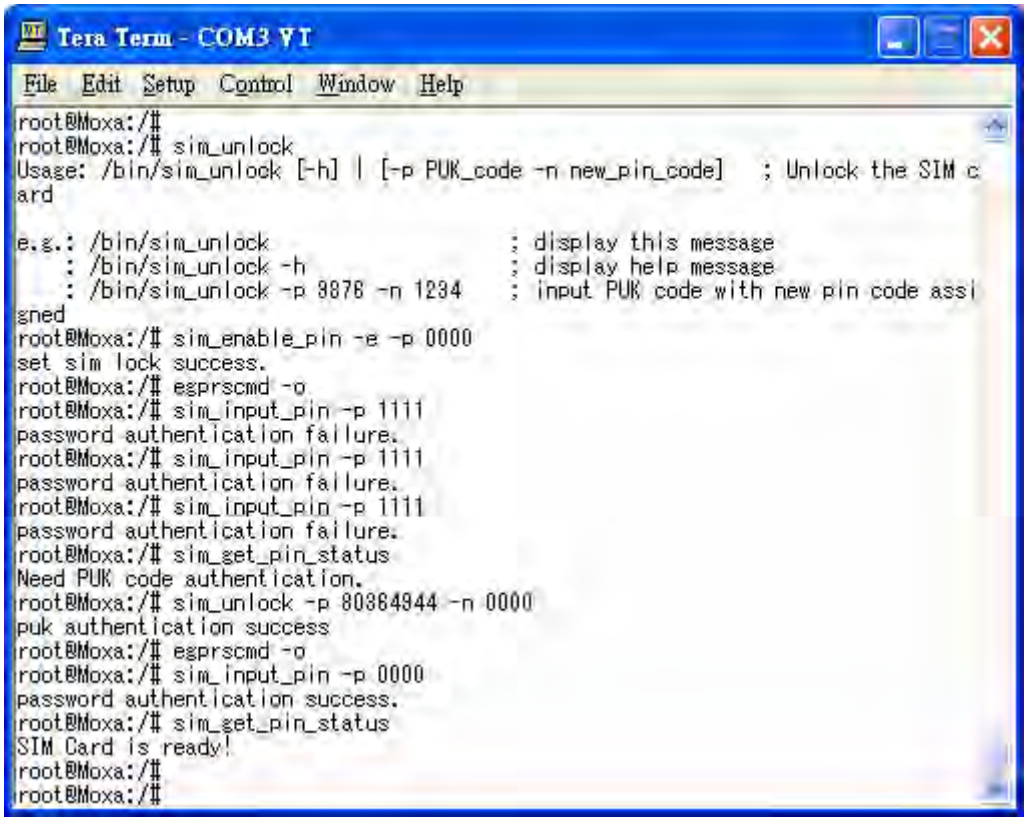
Changing the PIN Code

Use **sim_change_pin -o old PIN code –n new PIN code** command to change the PIN code. For example, enter **sim_input_pin –o 0000 –n 1111** to replace an old PIN code, 0000, with a new one, 1111.



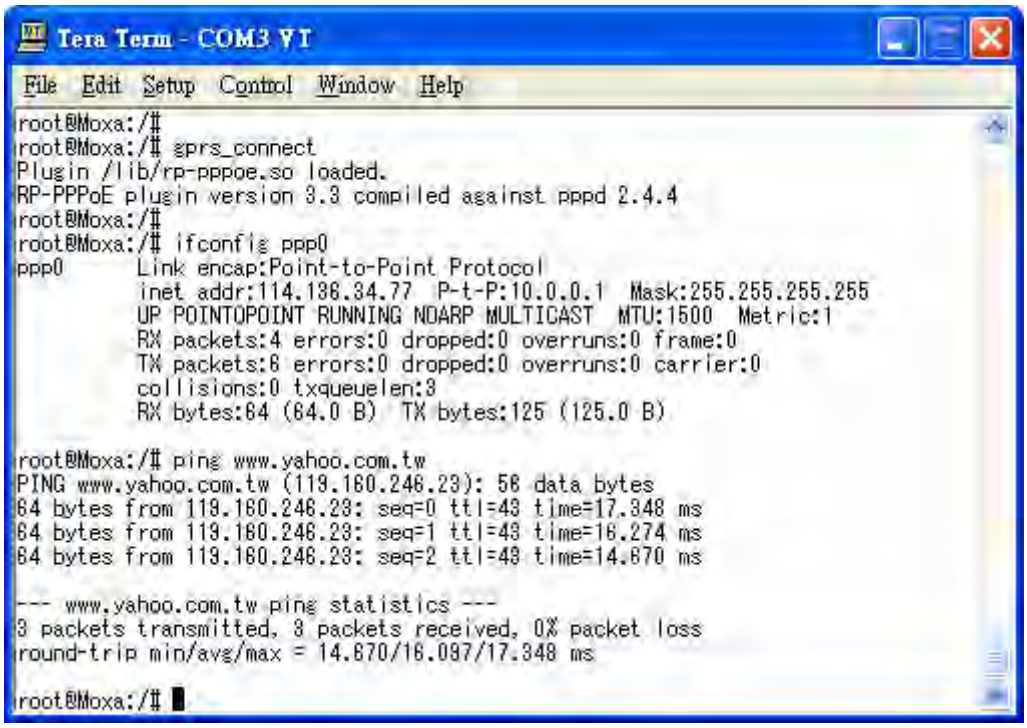
Unlocking the SIM Card

When your SIM has been locked, you will need to enter the PUK code to unlock your SIM card. Use the **sim_unlock –p PUK code –n new PIN code** command to unluck your card. Please note that when you enter the PUK code, you also need to provide a new PIN code. For example, type **sim_unlock –p 80364944 –n 0000**. In this case, 80364944 is the PUK code, while 0000 is the new PIN code. Use this new PIN code the next time the W406 starts.


Tera Term - COM3 VT
File Edit Setup Control Window Help
root@Moxa:/#
root@Moxa:/# sim_unlock
Usage: /bin/sim_unlock [-h] | [-p PUK_code -n new_pin_code] ; Unlock the SIM c
ard
e.g.: /bin/sim_unlock ; display this message
: /bin/sim_unlock -h ; display help message
: /bin/sim_unlock -p 8876 -n 1234 ; input PUK code with new pin code assi
gned
root@Moxa:/# sim_enable_pin -e -p 0000
set sim lock success.
root@Moxa:/# egprscmd -o
root@Moxa:/# sim_input_pin -p 1111
password authentication failure.
root@Moxa:/# sim_input_pin -p 1111
password authentication failure.
root@Moxa:/# sim_input_pin -p 1111
password authentication failure.
root@Moxa:/# sim_get_pin_status
Need PUK code authentication.
root@Moxa:/# sim_unlock -p 80364944 -n 0000
puk authentication success
root@Moxa:/# egprscmd -o
root@Moxa:/# sim_input_pin -p 0000
password authentication success.
root@Moxa:/# sim_get_pin_status
SIM Card is ready!
root@Moxa:/#
root@Moxa:/#

Connecting to the Internet

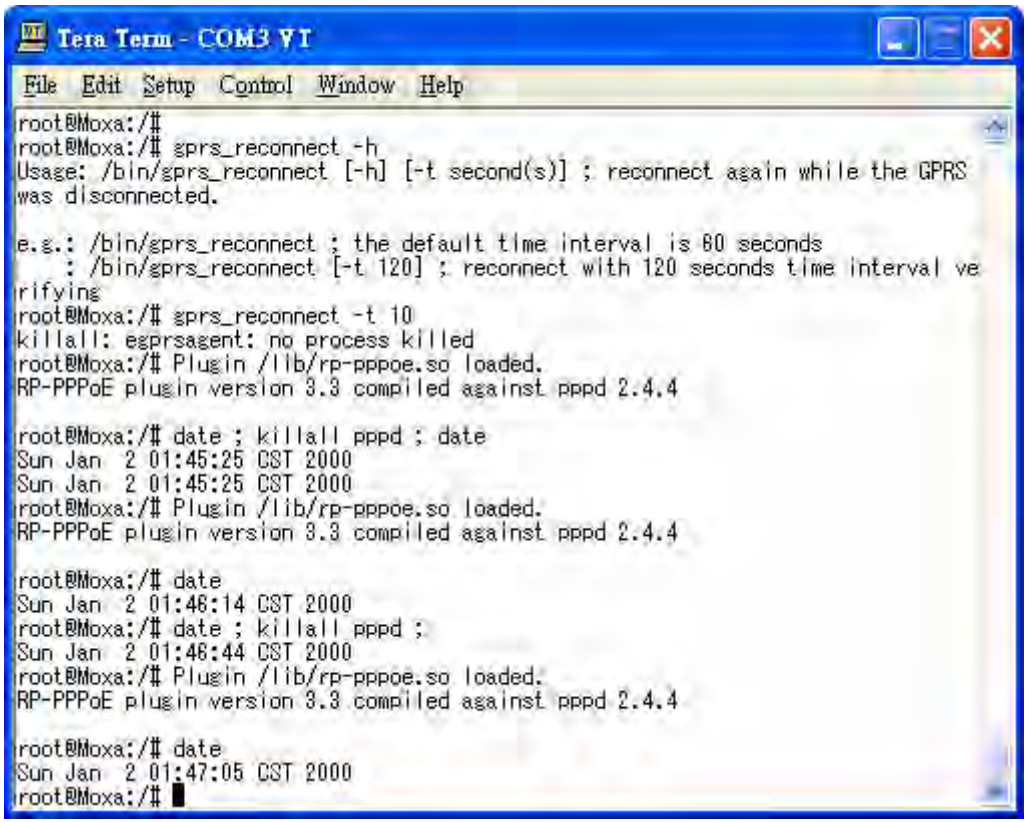
To create a connection, use the **gprs_connect** command.


Tera Term - COM3 VT
File Edit Setup Control Window Help
root@Moxa:/#
root@Moxa:/# gprs_connect
Plugin /lib/rp-pppoe.so loaded.
RP-PPPoE plugin version 3.3 compiled against pppd 2.4.4
root@Moxa:/#
root@Moxa:/# ifconfig ppp0
ppp0 Link encap:Point-to-Point Protocol
inet addr:114.136.34.77 P-t-P:10.0.0.1 Mask:255.255.255.255
UP POINTOPOINT RUNNING NOARP MULTICAST MTU:1500 Metric:1
RX packets:4 errors:0 dropped:0 overruns:0 frame:0
TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:3
RX bytes:64 (64.0 B) TX bytes:125 (125.0 B)
root@Moxa:/# ping www.yahoo.com.tw
PING www.yahoo.com.tw (119.160.246.23): 56 data bytes
64 bytes from 119.160.246.23: seq=0 ttl=43 time=17.348 ms
64 bytes from 119.160.246.23: seq=1 ttl=43 time=16.274 ms
64 bytes from 119.160.246.23: seq=2 ttl=43 time=14.670 ms
--- www.yahoo.com.tw ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 14.670/16.097/17.348 ms
root@Moxa:/#

For more detailed command syntax, type **gprs_connect –h**. While connected, you can use the **gprs_connection_status** command to check the connection status.

Reconnecting to the Internet

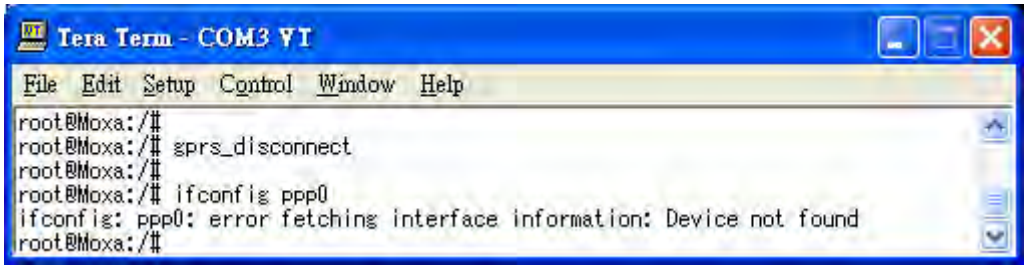
When an internet connection has been broken, use the **gprs_reconnect –t second** command to reconnect to the Internet. For example, enter **gprs_reconnect –t 120** to direct the W406 to attempt to reconnect to the Internet every 120 seconds. If you do not provide the time interval, the default value will be 60 seconds.


Tera Term - COM3 VT
File Edit Setup Control Window Help
root@Moxa:/#
root@Moxa:/# gprs_reconnect -h
Usage: /bin/gprs_reconnect [-h] [-t second(s)] ; reconnect again while the GPRS was disconnected.
e.g.: /bin/gprs_reconnect ; the default time interval is 60 seconds
: /bin/gprs_reconnect [-t 120] ; reconnect with 120 seconds time interval verifying
root@Moxa:/# gprs_reconnect -t 10
killall: egprsagent: no process killed
root@Moxa:/# Plugin /lib/rp-pppoe.so loaded.
RP-PPPoE plugin version 3.3 compiled against pppd 2.4.4
root@Moxa:/# date ; killall pppd ; date
Sun Jan 2 01:45:25 CST 2000
Sun Jan 2 01:45:25 CST 2000
root@Moxa:/# Plugin /lib/rp-pppoe.so loaded.
RP-PPPoE plugin version 3.3 compiled against pppd 2.4.4
root@Moxa:/# date
Sun Jan 2 01:46:14 CST 2000
root@Moxa:/# date ; killall pppd ;
Sun Jan 2 01:46:44 CST 2000
root@Moxa:/# Plugin /lib/rp-pppoe.so loaded.
RP-PPPoE plugin version 3.3 compiled against pppd 2.4.4
root@Moxa:/# date
Sun Jan 2 01:47:05 CST 2000
root@Moxa:/#

Use the **gprs_reconnect –h** command for more details.

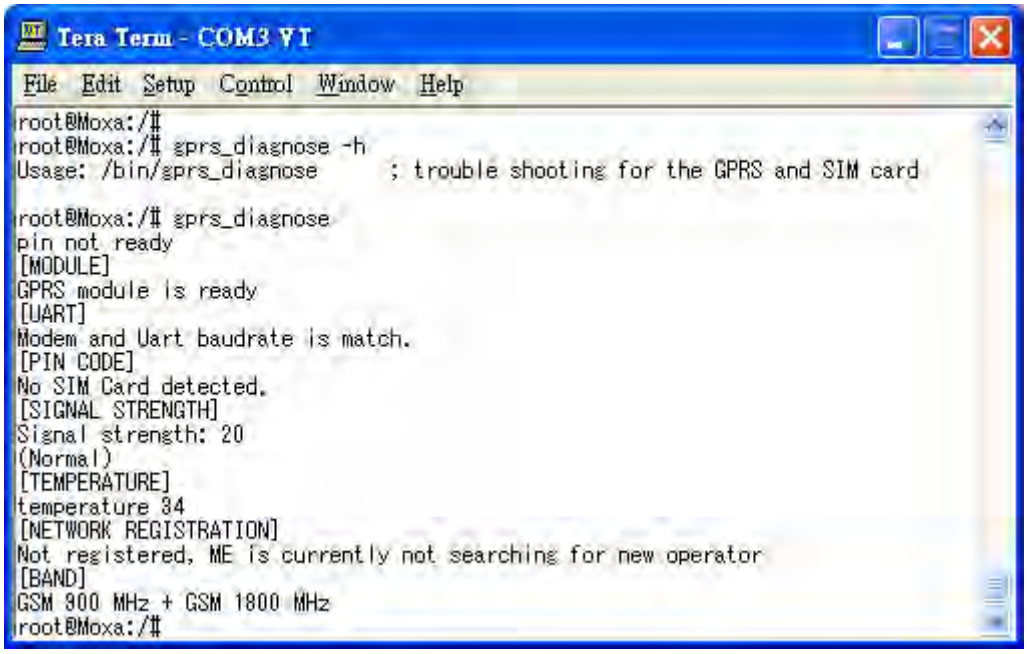
Disconnecting from the Internet

To disconnect from the Internet, use the **gprs_disconnect** command. After a few seconds, the embedded computer will disconnect from the GPRS network. A notification message will **NOT** be displayed.



Detecting an Internet Connection Error

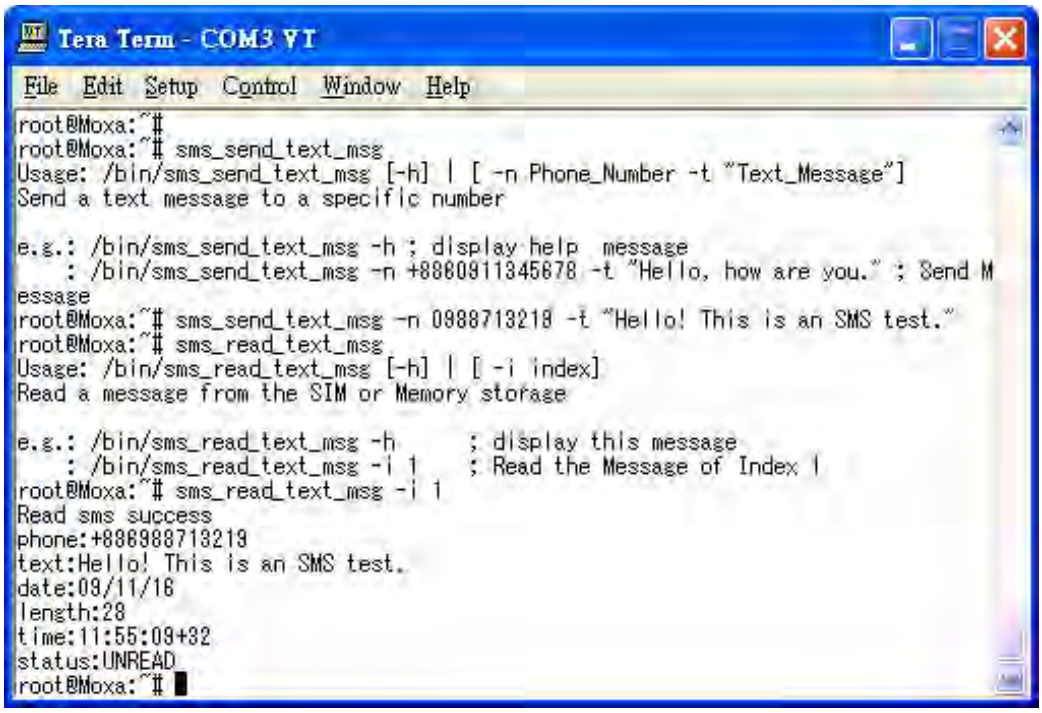
To diagnose a connection problem, use the **gprs_diagnose** command. This utility will execute a series of steps to check whether or not the configuration is correct. Most connection problems can be indentified with this command.



Sending and Reading an SMS Message

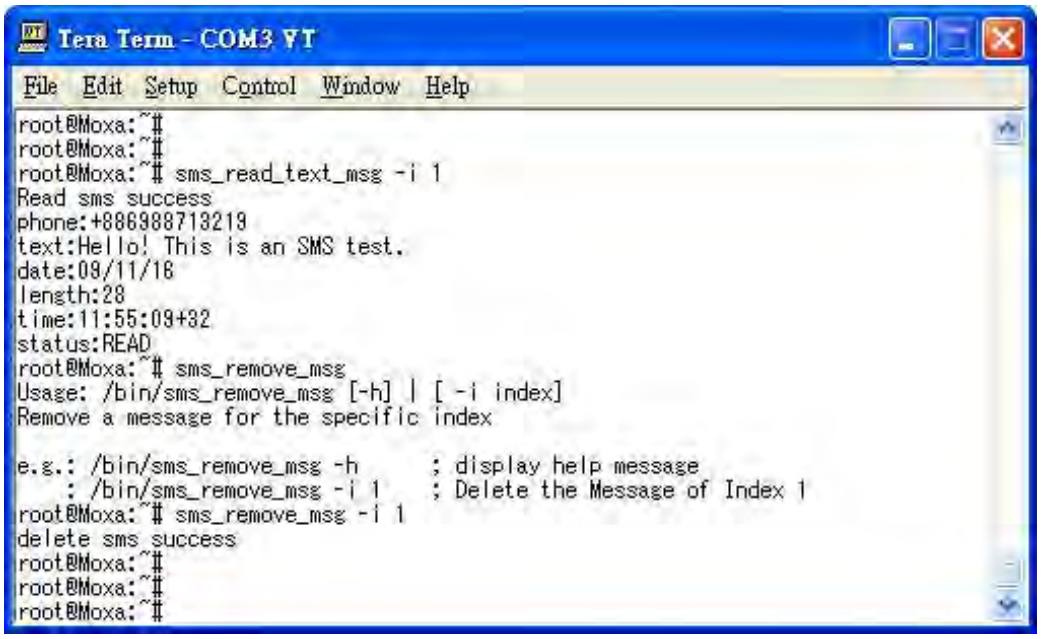
To send an SMS message, use the **sms_send_text_msg** command. For example, enter **sms_send_text_msg –n 0988713219 –t "hello! This is an SMS test."** to send the message "hello! This is an SMS test." to the phone number 0988693141.

To read an SMS message, use the **sms_read_text_msg –i** command. For example, **sms_read_text_msg –i 1**, will display the first SMS message.


Tera Term - COM3 VT
File Edit Setup Control Window Help
root@Moxa:~#
root@Moxa:~# sms_send_text_msg
Usage: /bin/sms_send_text_msg [-h] | [-n Phone_Number -t "Text_Message"]
Send a text message to a specific number
e.g.: /bin/sms_send_text_msg -h ; display help message
: /bin/sms_send_text_msg -n +8880911345678 -t "Hello, how are you." ; Send M
essage
root@Moxa:~# sms_send_text_msg -n 0988713219 -t "Hello! This is an SMS test."
root@Moxa:~# sms_read_text_msg
Usage: /bin/sms_read_text_msg [-h] | [-i index]
Read a message from the SIM or Memory storage
e.g.: /bin/sms_read_text_msg -h ; display this message
: /bin/sms_read_text_msg -i 1 ; Read the Message of Index 1
root@Moxa:~# sms_read_text_msg -i 1
Read sms success
phone:+886988713219
text:Hello! This is an SMS test.
date:09/11/16
length:28
time:11:55:09+32
status:UNREAD
root@Moxa:~#

Deleting an SMS Message

To delete an SMS message, use the **sms_remove_msg** command. For example, the **sms_remove_msg –i 1** command will delete the first SMS message.



Test Program—Developing Hello.c

In this section, we use the standard "Hello" programming example to illustrate how to develop a program for the W406-LX. In general, program development involves the following seven steps.

Step 1: Connect the W406-LX to a Linux PC.

Step 2: Install Tool Chain (GNU Cross Compiler & glibc).

Step 3: Set the cross compiler and glibc environment variables.

Step 4: Code and compile the program.

Step 5: Download the program to the W406-LX Via FTP or NFS.

Step 6: Debug the program

→ If bugs are found, return to Step 4.

→ If no bugs are found, continue with Step 7.

Step 7: Back up the user directory (distribute the program to additional W406-LX units if needed).

Installing the Tool Chain (Linux)

The Linux Operating System must be pre-installed in the PC before installing the W406-LX GNU Tool Chain. Fedora core or compatible versions are recommended. The Tool Chain requires approximately 1 GB of hard disk space on your PC. The W406-LX Tool Chain software is located on the W406-LX CD. To install the Tool Chain, insert the CD into your PC and then issue the following commands:

```
#mount /dev/cdrom /mnt/cdrom
#sh /mnt/cdrom/toolchain/arm-linux_x.x.sh (where x.x indicates the version of the Tool Chain)
```

The Tool Chain will be installed automatically on your Linux PC within a few minutes. Before compiling the program, be sure to set the following path first, since the Tool Chain files, including the compiler, link, and library, are located in this directory.

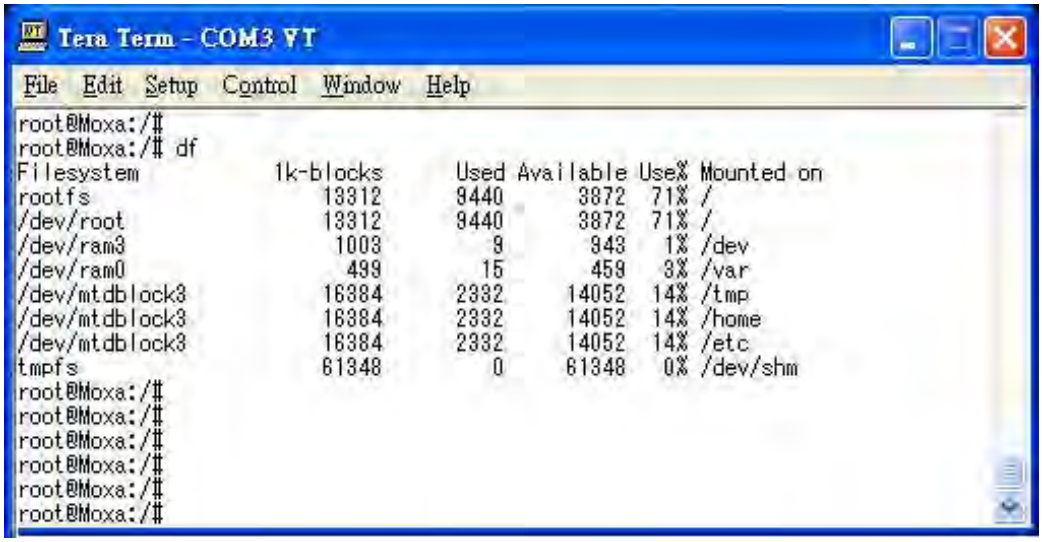
```
PATH=/usr/local/arm-linux/bin:$PATH
```

Setting the path allows you to run the compiler from any directory.

Checking the Flash Memory Space

If the flash memory is full, you will not be able to save data to the Flash ROM. Use the following command to calculate the amount of "Available" flash memory:

```
/>df -h
```



If there isn't enough "Available" space for your application, you will need to delete some existing files. To do this, connect your PC to the W406-LX with the console cable, and then use the console utility to delete the files from the W406-LX's flash memory. To check the amount of free space available, look at the directories in the read/write directory **/dev/mtdblock3**. Note that the directories **/home** and **/etc** are both mounted on the directory **/dev/mtdblock3**.

NOTE If the flash memory is full, you will need to free up some memory space before saving files to the Flash ROM.

Compiling Hello.c

The package CD contains several example programs. Here we use **hello.c** as an example to show you how to compile and run your applications. Type the following commands from your PC to copy the files used for this example from the CD to your computer's hard drive:

```
# cd /tmp/
# mkdir example
# cp –r /mnt/cdrom/example/* /tmp/example
```

To compile the program, go to the **hello** subdirectory and issue the following commands:

```
#cd example/hello
#make
```

You should receive the following response:

```
[root@localhost hello]# make
/usr/local/arm-linux/bin/arm-linux-gcc –o hello-release hello.c
/usr/local/arm-linux/bin/arm-linux-strip –s hello-release
/usr/local/arm-linux/bin/arm-linux-gcc –ggdb -o hello-debug hello.c
[root@localhost hello]# _
```

Next, execute **hello.exe**, both **hello-release** and **hello-debug** will be generated, which are described below:

hello-release—an ARM platform execution file (created specifically to run on the W406-LX)

hello-debug—an ARM platform GDB debug server execution file (see Chapter 5 for details about the GDB debug tool)

NOTE Since Moxa's tool chain places a specially designed **Makefile** in the directory **/tmp/example/hello**, be sure to type the **#make** command from within that directory. This special Makefile uses the arm-linux-gcc compiler to compile the hello.c source code for the ARM environment.

Uploading and Running the "Hello" Program

Use the following commands to upload **hello-release** to the W406-LX via FTP.

1. From the PC, type:

   ```
   #ftp 192.168.3.127
   ```

2. Use the bin command to set the transfer mode to Binary mode, and then use the put command to initiate the file transfer:

   ```
   ftp> bin
   ftp> put hello-release
   ```

3. From the W406-LX, type:

   ```
   # chmod +x hello-release
   # ./hello-release
   ```

The word **Hello** will be printed on the screen.

```
root@Moxa:~# ./hello-release
Hello
```

3

Managing Embedded Linux

This chapter includes information about version control, deployment, updates, and peripherals. The information in this chapter will be particularly useful when you need to run the same application on several W406-LX units.

The following topics are covered in this chapter:

- **System Version Information**
  - Upgrading the Firmware
  - Loading Factory Defaults
- **Enabling and Disabling Daemons**
- **Setting the Run-Level**
- **Adjusting the System Time**
  - Setting the Time Manually
  - NTP Client
  - Updating the Time Automatically
- **Cron—Daemon to Execute Scheduled Commands**

System Version Information

To determine the hardware capability of your W406-LX, and what kind of software functions are supported, check the version numbers of your W406-LX's kernel, and user file system. Contact Moxa to determine the hardware version. You will need the **Production S/N** (Serial Number), which is located on the W406-LX's bottom label.

To check the kernel version, type:

#kversion

NOTE: The kernel version number is for the factory default configuration, and if you download the latest firmware version from Moxa's website and then upgrade the W406's hardware, the kernel version will be different.

Upgrading the Firmware

The W406-LX's bios, kernel, and root file system are combined into one firmware file, which can be downloaded from Moxa's website (www.moxa.com). The name of the file has the form **W406-x.x.x.hfm**, with "x.x.x" indicating the firmware version. To upgrade the firmware, download the firmware file to a PC, and then transfer the file to the W406-LX via a Debug Port or Telnet Console connection.

ATTENTION

Upgrading the firmware will erase some data on the Flash ROM

Beware that updating the firmware will erase some of the data on the Flash ROM. We strongly suggest that you should back up your application files and data before updating the firmware.

Since different Flash disks have different sizes, it's a good idea to check the size of your Flash disk before upgrading the firmware, or before using the disk to store your application and data files. Use the **#df -h** command to list the size of each memory block and how much free space is available in each block.

```
192.168.3.127 – PuTTY
root@Moxa:~# df -h
Filesystem     Size      Used     Available Use% Mounted on
Rootfs         8.6M      7.8M      888.0k     90%   /
/dev/root      8.6M      7.8M      888.0k     90%   /
/dev/ram3      1003.0k   9.0k      943.0k      1% /dev
/dev/ram0      499.0k    18.0k     456.0k      4% /var
/dev/mtdblock3 5.0M      3.8M        1.2M     75% /tmp
/dev/mtdblock3 5.0M      3.8M        1.2M     75% /home
/dev/mtdblock3 5.0M      3.8M        1.2M     75% /etc
tmpfs          14.4M        0       14.4M      0% /dev/shm
/dev/ram1      15.5M      1.0k      14.7M      0% /var/ramdisk
root@Moxa:~# cd /mnt/ramdisk
root@Moxa:/mnt/ramdisk#
```

The following instructions give the steps required to save the firmware file to the W406-LX's RAM disk and how to upgrade the firmware.

1. Type the following commands to enable the RAM disk:

```
#upramdisk
#cd /mnt/ramdisk
```

2. Type the following commands to use the W406-LX's built-in FTP client to transfer the firmware file (**W406-x.x.x.hfm**) from the PC to the W406-LX:

```
/mnt/ramdisk> ftp <destination PC's IP>
Login Name: xxxx
Login Password: xxxx
ftp> bin
ftp> get W406-x.x.x.hfm
```

```
192.168.3.127 – PuTTY
root@Moxa:/mnt/ramdisk# ftp 192.168.3.193
Connected to 192.168.3.193 (192.168.3.193).
220 TYPSoft FTP Server 1.10 ready…
Name (192.168.3.193:root): root
331 Password required for root.
Password:
230 User root logged in.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> cd newsw
250 CWD command successful. "/C:/ftproot/newsw/" is current directory.
ftp> bin
200 Type set to I.
ftp> ls
200 Port command successful.
150 Opening data connection for directory list.
drw-rw-rw-    1 ftp  ftp    0 Nov 30 10:03 .
drw-rw-rw-    1 ftp  ftp    0 Nov 30 10:03 .
-rw-rw-rw-    1 ftp  ftp 13167772 Nov 29 10:24
W406-x.x.x.hfm
226 Transfer complete.
ftp> get W406-x.x.x.hfm
local: W406-x.x.x.hfm
remote: W406-x.x.x.hfm
200 Port command successful.
```

```
150 Opening data connection for  W406-x.x.x.hfm
226 Transfer complete.
13167772 bytes received in 2.17 secs (5925.8 kB/s)
ftp>
```

3. Next, use the **upgradehfm** command to upgrade the kernel and root file system:

#upgradehfm W406-x.x.x.hfm

```
   192.168.3.127 – PuTTY
root@Moxa:/mnt/ramdisk# upgradehfm  W406-x.x.x.hfm
Moxa  W406 upgrade firmware utility version 1.0.
To check source firmware file context.
The source firmware file context is OK.
This step will destroy all your firmware.
Continue ? (Y/N) : Y
Now upgrade the file [kernel].
Format MTD device [/dev/mtd1] . . .
MTD device [/dev/mtd1] erase 128 Kibyte @ 1C0000 – 100% complete.
Wait to write file . . .
Compleleted 100%
Now upgrade the file [usrdisk].
Format MTD device [/dev/mtd2] . . .
MTD device [/dev/mtd2] erase 128 Kibyte @ 800000 – 100% complete.
Wait to write file . . .
Compleleted 100%
Upgrade the firmware is OK.
```

ATTENTION

The **upgradehfm** utility will reboot your target after the upgrade is OK.

Loading Factory Defaults

To load the factory default settings, you must press the reset-to-default button for more than 5 seconds. All files in the /home & /etc directories will be deleted. Note that while pressing the reset-to-default button, the Ready LED will blink once every second for the first 5 seconds. The Ready LED will turn off after 5 seconds, and the factory defaults will be loaded.

Enabling and Disabling Daemons

The following daemons are enabled when the W406-LX boots up for the first time.

snmpd .....SNMP Agent daemon
telnetd .....Telnet Server daemon and Client
inetd .....Internet Daemons
ftpd.....FTP Server daemon and Client
sshd .....Secure Shell Server daemon
httpd .....Apache WWW Server daemon

Type the command "ps" to list all processes currently running.

```
192.168.3.127 - PuTTY
root@Moxa:~#
root@Moxa:
  PID USER     USZ  STAT  COMMAND
    1 root     1316 S     init [3]
    2 root        0  SW< [kthreadd]
    3 root        0  SW< [ksoftirqd/0]
    4 root        0  SW< [events/0]
    5 root        0  SW< [khelper]
   41 root        0  SW< [kblockd/0]
   51 root        0  SW< [khubd]
   54 root        0  SW< [kseriod]
   72 root        0  SW  [pdflush]
   73 root        0  SW  [pdflush]
   74 root        0  SW< [kswapd0]
   75 root        0  SW< [aio/0]
  740 root        0  SW< [mtdblockd]
  787 root        0  SW< [scsi_eh_1]
  788 root        0  SW< [usb-storage]
  799 root        0  SW< [rpciod/0]
  813 root        0  SWN [jffs2_gcd_mtd3]
  819 root     1392  S    smsd
  929 root     1360  S    /bin/inetd
  937 root    12580  S    /usr/bin/httpd –k start –d /etc/apache
  940 bin      1300  S   /bin/portmap
  943 root     2452  S   /bin/sh --login
  948 root     1360  S   /bin/snmpd
  954 root     1300  S   /bin/egprsagent
  955 root     1280  S   /bin/reportip
  958 root     1536  S   /sbin/getty  115200  tty1
  969 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
  970 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
  971 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
  972 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
  973 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
 1501 root     2164 R   ps
root@Moxa:/ect#
```

To run a private daemon, you can edit the file rc.local, as follows:

```
#cd /etc/rc.d
#vi rc.local
```

```
192.168.3.127 - PuTTY
root@Moxa:~# cd /etc/rc.d
root@Moxa:/etc/rc.d# vi rc.local
```

Next, use vi to open your application script. We use the example program **tcps2-release**, and put it to run in the background.

```
192.168.3.127 - PuTTY
# !/bin/sh
# Add you want to run daemon
/home/tcpserver &
```

The enabled daemons will be available after you reboot the system.

```
192.168.3.127 – PuTTY
root@Moxa:~# ps
  PID  USER      USZ  STAT  COMMAND
    1  root     1316 S     init [3]
    2  root        0 SW< [kthreadd]
    3  root        0 SW< [ksoftirqd/0]
    4  root        0 SW< [events/0]
    5  root        0 SW< [khelper]
   41  root        0 SW< [kblockd/0]
   51  root        0 SW< [khubd]
   54  root        0 SW< [kseriod]
   72  root        0 SW  [pdflush]
   73  root        0 SW  [pdflush]
   74 root         0 SW< [kswapd0]
   75 root         0 SW< [aio/0]
  740 root         0 SW< [mtdblockd]
  787 root         0 SW< [scsi_eh_1]
  788 root         0 SW< [usb-storage]
  799 root         0 SW< [rpciod/0]
  813 root         0 SWN [jffs2_gcd_mtd3]
  819 root      1392 S    smsd
  929 root      1360 S   /bin/inetd
  937 root     12580 S   /usr/bin/httpd –k start –d /etc/apache
  940 bin       1300 S   /bin/portmap
  943 root      2460 S    /bin/sh –login
  948 root      1360 S    /bin/snmpd
  954 root      1300 S    /bin/egprsagent
  955 root      1280 S    /bin/reportip
  958 root      1536 S    /sbin/getty 115200 tty1
  969 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
  970 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
  971 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
  972 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
  973 nobody   12604 S   /usr/bin/httpd -k start -d /etc/apache
 1510 root     1276 S   /tmp/tcpserver
 1511 root     2164 R   ps
root@Moxa:~#
```

Setting the Run-Level

In this section, we outline the steps you should take to set the Linux run-level and execute requests. Use the following command to enable or disable settings:

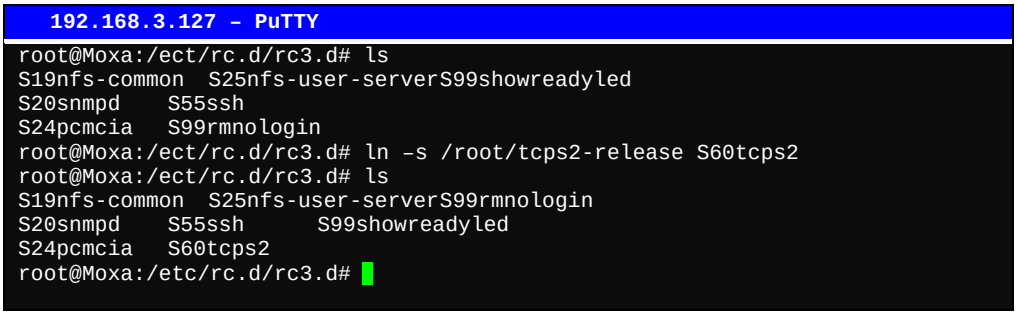
```
192.168.3.127 – PuTTY
root@Moxa:/ect/rc.d/rc3.d# ls
S20snmpd
S99showreadyled   S99rmnologin
root@Moxa:/etc/rc.d/rc3.d#
```

#cd /etc/rc.d/init.d

Edit a shell script to execute **/root/tcps2-release** and save to **tcps2** as an example.

```
#cd /etc/rc.d/rc3.d
#ln –s /etc/rc.d/init.d/tcps2 S60tcps2
```

SxxRUNFILE stands for
S: start the run file while linux boots up.
xx: a number between 00-99. Smaller numbers have a higher priority.
RUNFILE: the file name.



KxxRUNFILE stands for
K: start the run file while linux shuts down or halts.
xx: a number between 00-99. Smaller numbers have a higher priority.
RUNFILE: the file name.

To remove the daemon, remove the run file from the **/etc/rc.d/rc3.d** directory by using the following command:

#rm –f /etc/rc.d/rc3.d/S60tcps2

Adjusting the System Time

Setting the Time Manually

The W406-LX has two time settings. One is the system time, and the other is the RTC (Real Time Clock) time kept by the W406-LX's hardware. Use the **#date** command to query the current system time or set a new system time. Use **#hwclock** to query the current RTC time or set a new RTC time.

Use the following command to query the system time:
#date

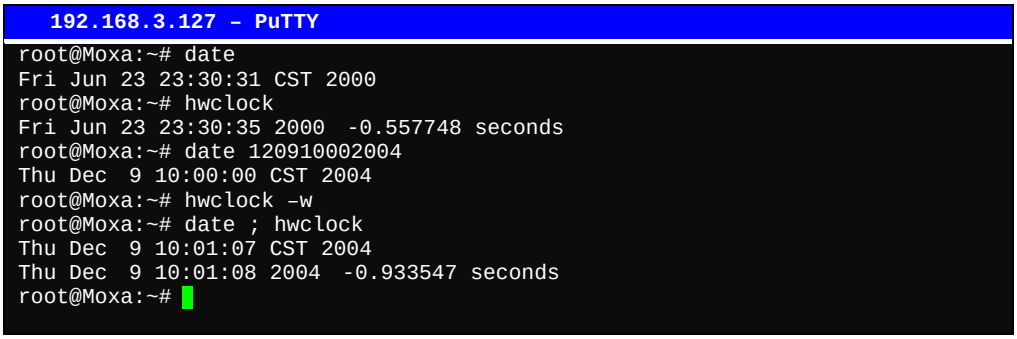
Use the following command to query the RTC time:
#hwclock

Use the following command to set the system time:
#date MMDDhhmmYYYY

MM = Month
DD = Date
hhmm = hour and minute
YYYY = Year

Use the following command to set the RTC time:
#hwclock –w

The following figure illustrates how to update the system time and set the RTC time.

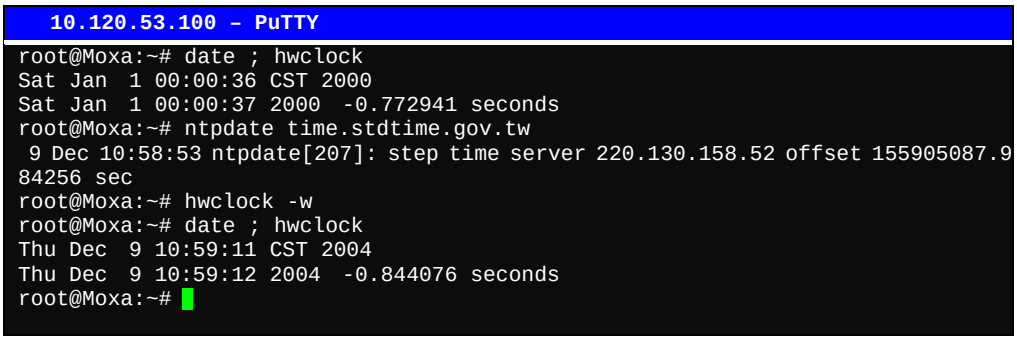

192.168.3.127 – PuTTY
root@Moxa:~# date
Fri Jun 23 23:30:31 CST 2000
root@Moxa:~# hwclock
Fri Jun 23 23:30:35 2000 -0.557748 seconds
root@Moxa:~# date 120910002004
Thu Dec 9 10:00:00 CST 2004
root@Moxa:~# hwclock –w
root@Moxa:~# date ; hwclock
Thu Dec 9 10:01:07 CST 2004
Thu Dec 9 10:01:08 2004 -0.933547 seconds
root@Moxa:~#

NTP Client

The W406-LX has a built-in NTP (Network Time Protocol) client that is used to initialize a time request to a remote NTP server. Use **#ntpdate <server name>** to update the system time.

```
#ntpdate time.stdtime.gov.tw
#hwclock –w
```

Visit http://www.ntp.org for more information about NTP and NTP server addresses.


10.120.53.100 – PuTTY
root@Moxa:~# date ; hwclock
Sat Jan 1 00:00:36 CST 2000
Sat Jan 1 00:00:37 2000 -0.772941 seconds
root@Moxa:~# ntpdate time.stdtime.gov.tw
9 Dec 10:58:53 ntpdate[207]: step time server 220.130.158.52 offset 155905087.9
84256 sec
root@Moxa:~# hwclock -w
root@Moxa:~# date ; hwclock
Thu Dec 9 10:59:11 CST 2004
Thu Dec 9 10:59:12 2004 -0.844076 seconds
root@Moxa:~#

NOTE Before using the NTP client utility, check your IP and DNS settings to make sure that an Internet connection is available. Refer to Chapter 2 for instructions on how to configure the Ethernet interface, and see Chapter 4 for DNS setting information.

Updating the Time Automatically

In this subsection, we show how to use a shell script to update the time automatically.

Example shell script to update the system time periodically

```
#!/bin/sh
ntpdate time.nist.gov # You can use the time server's ip address or domain
        # name directly. If you use domain name, you must
        # enable the domain client on the system by updating
        # /etc/resolv.conf file.
hwclock --systohc
sleep 100  # Updates every 100 seconds. The min. time is 100 seconds. Change
    # 100 to a larger number to update RTC less often.
```

Save the shell script using any file name. E.g., **fixtime**

How to run the shell script automatically when the kernel boots up

Copy the example shell script **fixtime** to directory **/etc/init.d**, and then use **chmod 755 fixtime** to change the shell script mode. Next, use vi editor to edit the file **/etc/inittab**. Add the following line to the bottom of the file:

```
ntp : 2345 : respawn : /etc/init.d/fixtime
```

Use the command **#init q** to re-init the kernel.

Cron—Daemon to Execute Scheduled Commands

Start Cron from the file **/etc/rc.d/rc.local**. It will return immediately, so you don't need to start it with '&' to run in the background.

The Cron daemon will search **/etc/cron.d/crontab** for crontab files.

Cron wakes up every minute, and checks each command to see if it should be run in the current minute. Modify the file **/etc/cron.d/crontab** to set up your scheduled applications. Crontab files have the following format:

min	hour	date	month	week	user	command
0-59	0-23	1-31	1-12	0-6 (0 is Sunday)		

The following example demonstrates how to use Cron.

How to use cron to update the system time and RTC time every day at 8:00

STEP1: Write a shell script named fixtime.sh and save it to /home/.

```
#!/bin/sh
ntpdate time.nist.gov
hwclock --systohc
exit 0
```

STEP2: Change mode of fixtime.sh

```
#chmod 755 fixtime.sh
```

STEP3: Modify /etc/cron.d/crontab file to run fixtime.sh at 8:00 every day.

Add the following line to the end of the crontab:

```
* 8 * * * root /home/fixtime.sh
```

STEP4: Enable the cron daemon manually.

```
#/etc/init.d/cron start
```

STEP5: Enable cron when the system boots up.

Add the following line in the file /etc/rc.d/rc.local

```
/etc/init.d/cron start
```

4

Managing Communications

In this chapter, we explain how to configure the W406-LX's various communication functions.

The following topics are covered in this chapter:

- **Telnet / FTP**
- **DNS**
- **Web Service—Apache**
- **Install PHP for Apache Web Server**
- **IPTABLES**
- **NAT**
  - NAT Example
  - Enabling NAT at Bootup
- **Dial-up Service—PPP**
- **PPPoE**
- **NFS (Network File System)**
  - Setting up the W406-LX as an NFS Client
- **Mail**
- **SNMP**
- **Package Management—ipkg**
- **OpenVPN**

Telnet / FTP

In addition to supporting Telnet client/server and FTP client/server, the W406-LX also supports SSH and sftp client/server. To enable or disable the Telnet/ftp server, you first need to edit the file **/etc/inetd.conf**.

Enabling the Telnet/ftp server

The following example shows the default content of the file /etc/inetd.conf. The default is to enable the Telnet/ftp server:

```
discard dgram  udp wait   root /bin/discard
discard stream tcp nowait root /bin/discard
ftp    stream tcp nowait root /bin/ftpd -l
ssh    stream tcp nowait root /bin/sshd -i -f /etc/config/ssh/sshd_config
telnet  stream tcp nowait root /bin/telnetd
```

Disabling the Telnet/ftp server

Disable the daemon by typing '#' in front of the first character of the row to comment out the line.

DNS

The W406-LX supports DNS client (but not DNS server). To set up DNS client, you need to edit three configuration files: **/etc/hosts, /etc/resolv.conf, and /etc/nsswitch.conf.**

/etc/hosts

This is the first file that the Linux system reads to resolve the host name and IP address.

/etc/resolv.conf

This is the most important file that you need to edit when using DNS for the other programs. For example, before you use #ntpdate time.nist.gov to update the system time, you will need to add the DNS server address to the file. Ask your network administrator which DNS server address you should use. The DNS server's IP address is specified with the "nameserver" command. For example, add the following line to /etc/resolv.conf if the DNS server's IP address is 168.95.1.1:

```
nameserver 168.95.1.1
```

/etc/nsswitch.conf

This file defines the sequence to resolve the IP address by using /etc/hosts file or /etc/resolv.conf.

Web Service—Apache

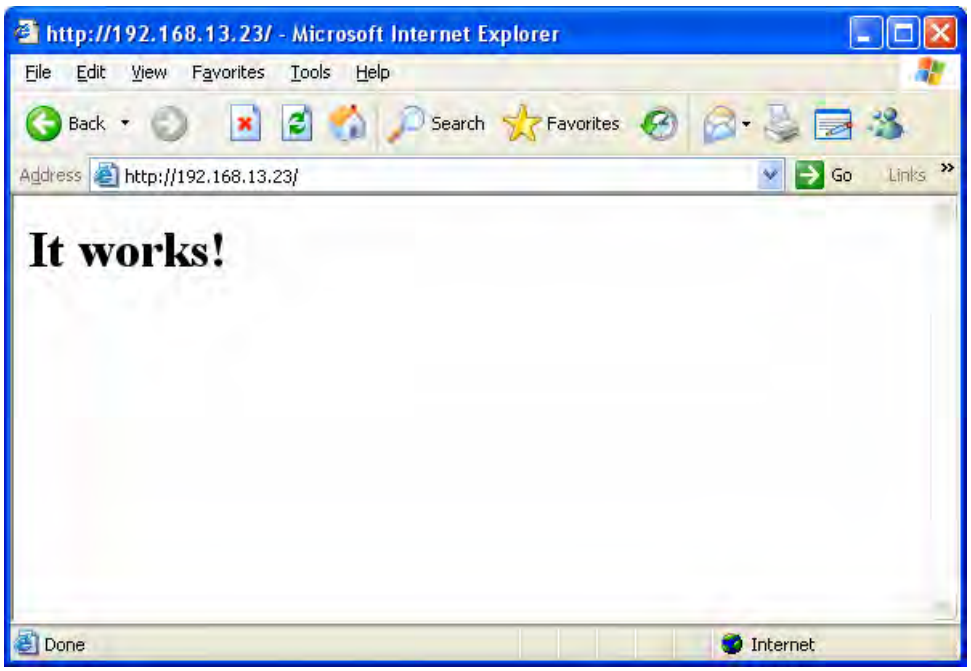
The Apache web server's main configuration file is **`/etc/apache/conf/httpd.conf`**, with the default homepage located at **`/home/httpd/htdocs/index.html`**. Save your own homepage to the following directory:

/home/httpd/htdocs/

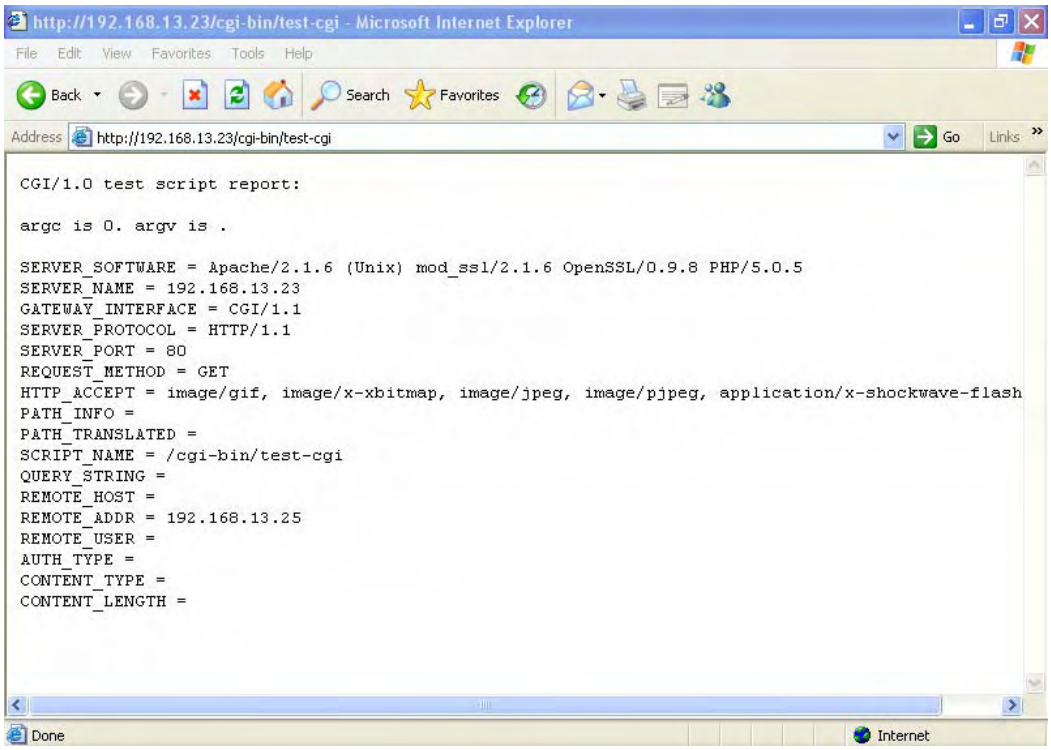
Save your CGI page to the following directory:

/home/httpd/cgi-bin/

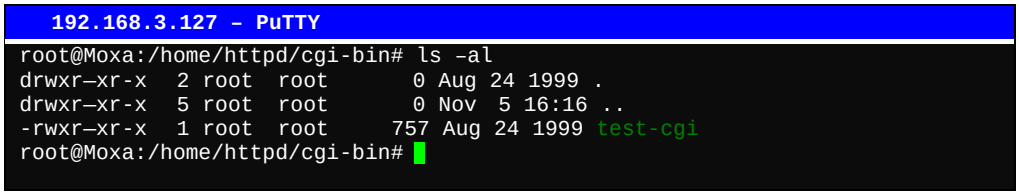
Before you modify the homepage, use a browser (such as Microsoft Internet Explorer or Mozilla Firefox) from your PC to test if the Apache Web Server is working. Type the IP address of LAN1 in the browser's address box to open the homepage. E.g , type **http://192.168.13.23** in the address box.



To open the default CGI page, type **http://192.168.13.23/cgi-bin/test-cgi** in your browser's address box.



NOTE The CGI function is enabled by default. If you want to disable the function, modify the file **/etc/apache/conf/httpd.conf**. When you develop your own CGI application, make sure your CGI file is executable.


192.168.3.127 – PuTTY
root@Moxa:/home/httpd/cgi-bin# ls -al
drwxr-xr-x 2 root root 0 Aug 24 1999 .
drwxr-xr-x 5 root root 0 Nov 5 16:16 ..
-rwxr-xr-x 1 root root 757 Aug 24 1999 test-cgi
root@Moxa:/home/httpd/cgi-bin#

Install PHP for Apache Web Server

This embedded computer supports the PHP option. However, since the PHP file is 3 MB, it is not installed by default. To install it yourself, first make sure there is enough free space (at least 3 MB) on your embedded flash ROM).

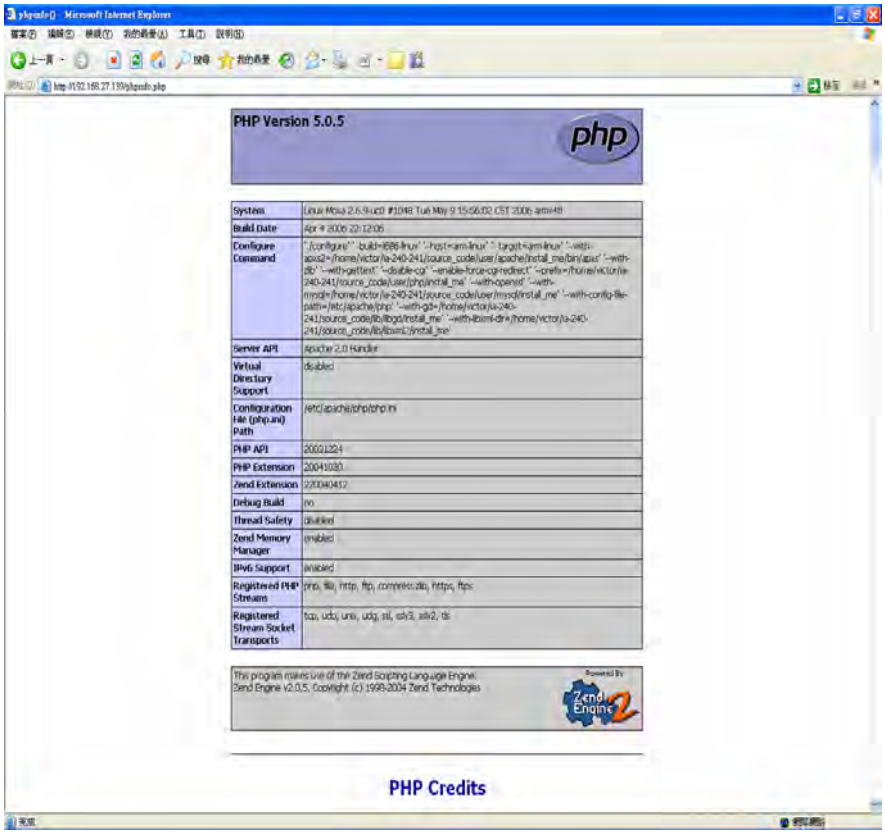
Step 1: Type '**upramdisk**' to get the free space ram disk to save the package. Check that you have enough free space.

```
192.168.3.127 - PuTTY
root@Moxa:/bin# upramdisk
root@Moxa:/bin# df -h
Filesystem              Size      Used   Available  Use% Mounted on
Rootfs                  8.6M      7.8M       888.0k  90%   /
/dev/root               8.6M      7.8M       888.0k  90%   /
/dev/ram3            1003.0k      9.0k       943.0k   1%   /dev
/dev/ram0             499.0k     18.0k       456.0k   4%   /var
/dev/mtdblock3          5.0M      3.8M       1.2M    76%   /tmp
/dev/mtdblock3          5.0M      3.8M       1.2M    76%   /home
/dev/mtdblock3          5.0M      3.8M       1.2M    76%   /etc
tmpfs                  14.4M         0      14.4M     0%   /dev/shm
/dev/ram1              15.5M      1.0k      14.7M     0%   /var/ramdisk
root@Moxa:/bin#
```

To check that the **/dev/ram1** free space is greater than 3 MB.

Step 2: Download the PHP package from the CD-ROM. Refer to Package Management-ipkg to install the PHP module.

Step 3: Test it. Use the browser to access http://192.168.27.139/phpinfo.php.



IPTABLES

IPTABLES is an administrative tool for setting up, maintaining, and inspecting the Linux kernel's IP packet filter rule tables. Several different tables are defined, with each table containing built-in chains and user-defined chains.

Each chain is a list of rules that apply to a certain type of packet. Each rule specifies what to do with a matching packet. A rule (such as a jump to a user-defined chain in the same table) is called a "target."

The W406-LX supports 3 types of IPTABLES table: **Filter** tables, **NAT** tables, and **Mangle** tables:

A. **Filter Table**—includes three chains:

INPUT chain—filters all incoming traffic destined for the local host. Note that all incoming packets destined for this host pass through this chain, no matter what interface or direction they came from.

OUTPUT chain—filters packets sent from the local host.

FORWARD chain—routs and filters forwarded packets only. Note that all forwarded traffic passes through this chain (not only in one direction), so you need to consider this factor when writing your rule-set.

B. **NAT Table**—includes three chains:

PREROUTING chain—transfers the destination IP address (DNAT)

POSTROUTING chain—works after the routing process and before the Ethernet device process to transfer the source IP address (SNAT)

OUTPUT chain—produces local packets

Sub-tables

Source NAT (SNAT)—changes the first source packet IP address.

Destination NAT (DNAT)—changes the first destination packet IP address.

MASQUERADE—a special form for SNAT. If one host can connect to Internet, then other computers that connect to this host can connect to the Internet when the computer does not have an actual IP address.

REDIRECT—a special form of DNAT that re-sends packets to a local host independent of the destination IP address.

C. **Mangle Table**—includes the following chains:

INPUT—mangles packets after they have been routed, but before they are actually sent to the processing machine.

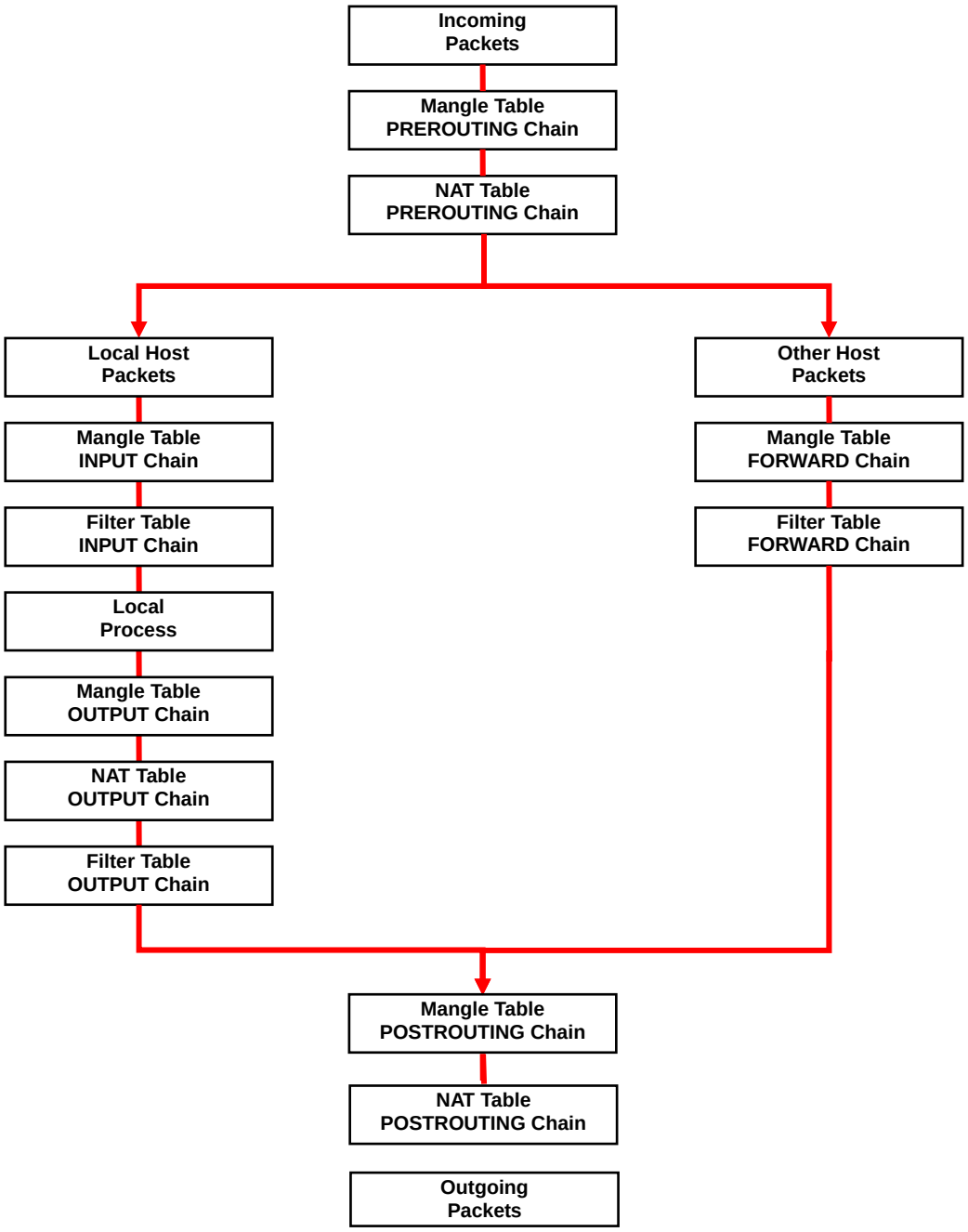
FORWARD—mangles the packet after the initial routing decision, but before the last routing decision prior to sending the packet the out.

PREROUTING chain—pre-processes packets before the routing process.

OUTPUT chain—processes packets after the routing process.

It has three extensions—TTL, MARK, and TOS.

The following figure shows the IPTABLES hierarchy.



The W406-LX supports the following sub-modules. Be sure to use the module that matches your application.

ip_queue	ipt_REDIRECT	ipt_ah	iptable_filter
ip_tables	ipt_REJECT	ipt_ecn	iptable_mangle
ipt_CLUSTERIP	ipt_SAME	ipt_iprange	iptable_nat
ipt_ECN	ipt_TOS	ipt_owner	iptable_raw
ipt_LOG	ipt_TTL	ipt_recent	
ipt_MASQUERADE	ipt_ULOG	ipt_tos	
ipt_NETMAP	ipt_addrtype	ipt_ttl	

NOTE The W406-LX does NOT support IPv6 and ipchains.

The basic syntax to enable and load an IPTABLES module is as follows:

```
#lsmod
#modprobe ip_tables
```

Use the following command to load the modules (iptable_filter, iptable_mangle, iptable_nat):

```
#modprobe iptable_filter
```

Use **lsmod** to check if the ip_tables module has already been loaded in the W406-LX. Use **modprobe** to insert and enable the module.

NOTE IPTABLES plays the role of packet filtering or NAT. Take care when setting up the IPTABLES rules. If the rules are not correct, remote hosts that connect via a LAN or PPP may be denied access. We recommend using the Serial Console to set up the IPTABLES.

Click on the following links for more information about iptables.

http://www.linuxguruz.com/iptables/
http://www.netfilter.org/documentation/HOWTO//packet-filtering-HOWTO.html

Since the IPTABLES command is very complex, to illustrate the IPTABLES syntax we have divided our discussion of the various rules into three categories: **Observe and erase chain rules**, **Define policy rules,** and **Append or delete rules**.

Observe and erase chain rules

Usage:

 # iptables [-t tables] [-L] [-n]

-t tables: Table to manipulate (default: 'filter'); example: nat or filter.
-L [chain]: ListList all rules in selected chains. If no chain is selected, all chains are listed.
-n: Numeric output of addresses and ports.

 # iptables [-t tables] [-FXZ]

-F: Flush the selected chain (all the chains in the table if none is listed).
-X: Delete the specified user-defined chain.
-Z: Set the packet and byte counters in all chains to zero.

Examples:

 # iptables -L -n

In this example, since we do not use the -t parameter, the system uses the default 'filter' table. Three chains are included: INPUT, OUTPUT, and FORWARD. INPUT chains are accepted automatically, and all connections are accepted without being filtered.

```
#iptables –F
#iptables –X
#iptables -Z
```

Define policy for chain rules

Usage:

 # iptables [-t tables] [-P] [INPUT, OUTPUT, FORWARD, PREROUTING, OUTPUT, POSTROUTING] [ACCEPT, DROP]

-P: Set the policy for the chain to the given target.
INPUT: For packets coming into the W406-LX.
OUTPUT: For locally-generated packets.
FORWARD: For packets routed out through the W406-LX.
PREROUTING: To alter packets as soon as they come in.
POSTROUTING: To alter packets as they are about to be sent out.

Examples:

```
#iptables –P INPUT DROP
#iptables –P OUTPUT ACCEPT
#iptables –P FORWARD ACCEPT
#iptables –t nat –P PREROUTING ACCEPT
#iptables –t nat –P OUTPUT ACCEPT
#iptables -t nat –P POSTROUTING ACCEPT
```

In this example, the policy accepts outgoing packets and denies incoming packets.

Append or delete rules:

Usage:

```
# iptables [-t table] [-AI] [INPUT, OUTPUT, FORWARD] [-io interface] [-p tcp, udp, icmp,
all] [-s IP/network] [--sport ports] [-d IP/network] [--dport ports] –j [ACCEPT. DROP]
```

-A: Append one or more rules to the end of the selected chain.
-I: Insert one or more rules in the selected chain as the given rule number.
-i: Name of an interface via which a packet is going to be received.
-o: Name of an interface via which a packet is going to be sent.
-p: The protocol of the rule or of the packet to check.
-s: Source address (network name, host name, network IP address, or plain IP address).
--sport: Source port number.
-d: Destination address.
--dport: Destination port number.
-j: Jump target. Specifies the target of the rules; i.e., how to handle matched packets. For example, ACCEPT the packet, DROP the packet, or LOG the packet.

Examples:

Example 1: Accept all packets from lo interface.
```
# iptables –A INPUT –i lo –j ACCEPT
```

Example 2: Accept TCP packets from 192.168.0.1.
```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.0.1 –j ACCEPT
```

Example 3: Accept TCP packets from Class C network 192.168.1.0/24.
```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.1.0/24 –j ACCEPT
```

Example 4: Drop TCP packets from 192.168.1.25.
```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.1.25 –j DROP
```

Example 5: Drop TCP packets addressed for port 21.
```
# iptables –A INPUT –i eth0 –p tcp --dport 21 –j DROP
```

Example 6: Accept TCP packets from 192.168.0.24 to W406-LX's port 137, 138, 139

```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.0.24 --dport 137:139 –j ACCEPT
```

Example 7: Log TCP packets that visit W406-LX's port 25.
```
# iptables –A INPUT –i eth0 –p tcp --dport 25 –j LOG
```

Example 8: Drop all packets from MAC address 01:02:03:04:05:06.
```
# iptables –A INPUT –i eth0 –p all –m mac –mac-source 01:02:03:04:05:06 –j DROP
```

NOTE: In Example 8, remember to issue the command **#modprobe ipt_mac** first to load module **ipt_mac**.

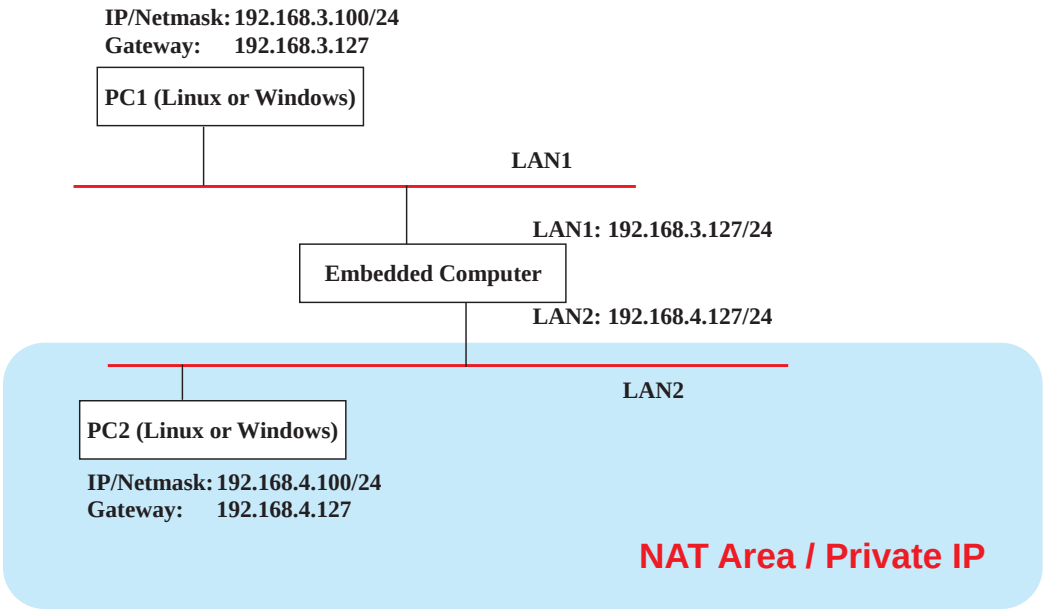
NAT

NAT (Network Address Translation) protocol translates IP addresses used on one network to different IP addresses used on another network. One network is designated the inside network and the other designated the outside network. Typically, the W406-LX connects several devices on a network and maps local inside network addresses to one or more global outside IP addresses, and un-maps the global IP addresses on incoming packets back into local IP addresses.

NOTE Click on the following link for more information about iptables and NAT:
http://www.netfilter.org/documentation/HOWTO/NAT-HOWTO.html

NAT Example

The IP address of LAN1 is changed to 192.168.3.127 (you will need to load the module ipt_MASQUERADE):




```
1.  #echo 1 > /proc/sys/net/ipv4/ip_forward
2.  #modprobe  ip_tables
3.  #modprobe  iptable_ filter
4.  #modprobe  ip_conntrack
5.  #modprobe  iptable_nat
6.  #modprobe  ipt_MASQUERADE
7.  #iptables -t nat -A POSTROUTING -o eth0 -j SNAT --to-source 192.168.3.127
8.  #iptables -t nat -A POSTROUTING -o eth0 -s 192.168.3.0/24 -j MASQUERADE
```

Enabling NAT at Bootup

In most real world situations, you will want to use a simple shell script to enable NAT when the W406-LX boots up. The following script is an example.

```
#!/bin/bash
# If you put this shell script in the /home/nat.sh
# Remember to chmod 744 /home/nat.sh
# Edit the rc.local file to make this shell startup automatically.
# vi /etc/rc.d/rc.local
# Add a line in the end of rc.local /home/nat.sh
EXIF='eth0'  #This is an external interface for setting up a valid IP address.
EXNET='192.168.4.0/24'  #This is an internal network address.
# Step 1. Insert modules.
# Here 2> /dev/null means the standard error messages will be dump to null device.
modprobe ip_tables  2> /dev/null
modprobe ip_nat_ftp  2> /dev/null
modprobe ip_nat_irc  2> /dev/null
modprobe ip_conntrack  2> /dev/null
modprobe ip_conntrack_ftp  2> /dev/null
modprobe ip_conntrack_irc  2> /dev/null
# Step 2. Define variables, enable routing and erase default rules.
PATH=/bin:/sbin:/usr/bin:/usr/sbin:/usr/local/bin:/usr/local/sbin
export PATH
```

```
echo "1" > /proc/sys/net/ipv4/ip_forward
/bin/iptables -F
/bin/iptables -X
/bin/iptables -Z
/bin/iptables -F -t nat
/bin/iptables -X -t nat
/bin/iptables -Z -t nat
/bin/iptables -P INPUT   ACCEPT
/bin/iptables -P OUTPUT  ACCEPT
/bin/iptables -P FORWARD ACCEPT
/bin/iptables -t nat -P PREROUTING  ACCEPT
/bin/iptables -t nat -P POSTROUTING ACCEPT
/bin/iptables -t nat -P OUTPUT     ACCEPT
# Step 3. Enable IP masquerade.
```

Dial-up Service—PPP

PPP (Point to Point Protocol) is used to run IP (Internet Protocol) and other network protocols over a serial link. PPP can be used for direct serial connections (using a null-modem cable) over a Telnet link, and links established using a modem over a telephone line.

Modem / PPP access is almost identical to connecting directly to a network through the W406-LX's Ethernet port. Since PPP is a peer-to-peer system, the W406-LX can also use PPP to link two networks (or a local network to the Internet) to create a Wide Area Network (WAN).

NOTE Click on the following links for more information about PPP:
http://tldp.org/HOWTO/PPP-HOWTO/index.html
http://axion.physics.ubc.ca/ppp-linux.html

The pppd daemon is used to connect to a PPP server from a Linux system. For detailed information about pppd see the man page.

Example 1: Connecting to a PPP server over a simple dial-up connection

The following command is used to connect to a PPP server by modem. Use this command for old ppp servers that prompt for a login name (replace *username* with the correct name) and password (replace *password* with the correct password). Note that *debug* and *defaultroute 192.1.1.17* are optional.

```
#pppd connect 'chat -v " " ATDT5551212 CONNECT" " ogin: username word: password'
/dev/ttyM0 115200 debug crtscts modem defaultroute
```

If the PPP server does not prompt for the username and password, the command should be entered as follows. Replace *username* with the correct username and replace *password* with the correct password.

```
#pppd connect 'chat -v " " ATDT5551212 CONNECT" " ' user username password password
/dev/ttyM0 115200 crtscts modem
```

The pppd options are described below:

connect 'chat etc...'
This option gives the command to contact the PPP server. The 'chat' program is used to dial a remote computer. The entire command is enclosed in single quotes because pppd expects a one-word argument for the 'connect' option. The options for 'chat' are given below:

-v
verbose mode; log what we do to syslog

" "

Double quotes—don't wait for a prompt, but proceed with the following instead (note that you must include a space before the second quotation mark).

ATDT5551212
Dial the modem, and proceed with the following.

CONNECT
Wait for an answer.

" "
Send a return (null text followed by the usual return)

ogin: *username* word: *password*
Log in with *username* and *password*.

Refer to the chat man page, chat.8, for more information about the chat utility.

/dev/
Specify the callout serial port.

115200
The baudrate.

debug
Log status in syslog.

crtscts
Use hardware flow control between computer and modem (at 115200 this is a must).

modem
Indicates that this is a modem device; pppd will hang up the phone before and after making the call.

defaultroute
Once the PPP link is established, make it the default route; if you have a PPP link to the Internet, this is probably what you want.

192.1.1.17
This is a degenerate case of a general option of the form x.x.x.x:y.y.y.y. Here x.x.x.x is the local IP address and y.y.y.y is the IP address of the remote end of the PPP connection. If this option is not specified, or if just one side is specified, then x.x.x.x defaults to the IP address associated with the local machine's hostname (located in **/etc/hosts**), and y.y.y.y is determined by the remote machine.

Example 2: Connecting to a PPP server over a hard-wired link

If a username and password are not required, use the following command (note that *noipdefault* is optional):

```
#pppd connect 'chat –v" " " " ' noipdefault /dev/ttyM0 19200 crtscts
```

If a username and password is required, use the following command (note that *noipdefault* is optional, and *root* is both the username and password):

```
#pppd connect 'chat –v" " " " ' user root password root noipdefault
/dev/ttyM0 19200 crtscts
```

How to check the connection

Once you've set up a PPP connection, there are some steps you can take to test the connection. First, type:

```
/sbin/ifconfig
```

(The file **ifconfig** may be located elsewhere, depending on your distribution.) You should be able to see all the network interfaces that are UP. ppp0 should be one of them, and you should recognize the first IP address as your own, and the "P-t-P address" (or point-to-point address) the address of your server. Here's what it looks like on one machine:

```
lo      Link encap Local Loopback
        inet addr 127.0.0.1     Bcast 127.255.255.255     Mask 255.0.0.0
        UP LOOPBACK RUNNING     MTU 2000     Metric 1
        RX packets 0 errors 0 dropped 0 overrun 0

ppp0    Link encap Point-to-Point Protocol
        inet addr 192.76.32.3     P-t-P 129.67.1.165     Mask 255.255.255.0
        UP POINTOPOINT RUNNING     MTU 1500     Metric 1
        RX packets 33 errors 0 dropped 0 overrun 0
        TX packets 42 errors 0 dropped 0 overrun 0
```

Now, type:

```
ping z.z.z.z
```

where z.z.z.z is the address of your name server. This should work. Here's what the response could look like:

```
Moxa:~$p ping 129.67.1.165
PING 129.67.1.165 (129.67.1.165): 56 data bytes
64 bytes from 129.67.1.165: icmp_seq=0 ttl=225 time=268 ms
64 bytes from 129.67.1.165: icmp_seq=1 ttl=225 time=247 ms
64 bytes from 129.67.1.165: icmp_seq=2 ttl=225 time=266 ms
^C
--- 129.67.1.165 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 247/260/268 ms
Moxa:~$
```

Try typing:

```
netstat -nr
```

This should show three routes, similar to the following:

```
Kernel routing table
Destination     Gateway         Genmask         Flags   Metric  Ref    Use
iface
129.67.1.165    0.0.0.0         255.255.255.255 UH      0       0      6
ppp0
127.0.0.0       0.0.0.0         255.0.0.0       U       0       0      0 lo
0.0.0.0         129.67.1.165    0.0.0.0         UG      0       0      6298
ppp0
```

If your output looks similar but doesn't have the destination 0.0.0.0 line (which refers to the default route used for connections), you may have run pppd without the 'defaultroute' option. At this point you can try using Telnet or ftp, bearing in mind that you'll have to use numeric IP addresses unless you've set up /etc/resolv.conf correctly.

Setting up a Machine for Incoming PPP Connections

This first example applies to using a modem, and requiring authorization with a username and password.

```
pppd/dev/ttyM0 115200 crtscts modem 192.168.16.1:192.168.16.2 login auth
```

You should also add the following line to the file **/etc/ppp/pap-secrets**:

```
*    *    ""    *
```

The first star (*) lets everyone login. The second star (*) lets every host connect. The pair of double quotation marks ("") is to use the file **/etc/passwd** to check the password. The last star (*) is to let any IP connect.

The following example does not check the username and password:

```
pppd/dev/ttyM0 115200 crtscts modem 192.168.16.1:192.168.16.2
```

PPPoE

1. Connect W406-LX's LAN port to an ADSL modem with a cross-over cable, HUB, or switch.
2. Log into the W406-LX as the root user.
3. Edit the file **/etc/ppp/chap-secrets** and add the following:

   "username@hinet.net"*"password"*

"username@hinet.net" is the username obtained from the ISP to log in to the ISP account.
"password" is the corresponding password for the account.

4. Edit the file **/etc/ppp/pap-secrets** and add the following:

   "username@hinet.net"*"password"*

```
# password if you don't use the login option of pppd! The mgetty Debian
# package already provides this option; make sure you don't change that.

# INBOUND connections

# Every regular user can use PPP and has to use passwords from /etc/passwd
#       hostname        ""      *
"username@hinet.net"    *       "password"      *

# UserIDs that cannot use PPP at all. Check your /etc/passwd and add any
# other accounts that should not be able to use pppd!
guest   hostname        "*"     -
master  hostname        "*"     -
root    hostname        "*"     -
support hostname        "*"     -
stats   hostname        "*"     -

# OUTBOUND connections

# Here you should add your userid password to connect to your providers via
# PAP. The * means that the password is to be used for ANY host you connect
# to. Thus you do not have to worry about the foreign machine name. Just
# replace password with your password.
"pap-secrets" line 1 of 42 --2%--
```

   "username@hinet.net" is the username obtained from the ISP to log in to the ISP account.
   "password" is the corresponding password for the account.

5. Edit the file **/etc/ppp/options** and add the following line:

   plugin pppoe

```
# terminated because it was idle.
#holdoff <n>

# Wait for up n milliseconds after the connect script finishes for a valid
# PPP packet from the peer.  At the end of this time, or when a valid PPP
# packet is received from the peer, pppd will commence negotiation by
# sending its first LCP packet.  The default value is 1000 (1 second).
# This wait period only applies if the connect or pty option is used.
#connect-delay <n>
plugin pppoe.so

# ---<End of File>---
~
~
~
~
~
~
~
~
~
~
~
"options" line 1 of 342 --0%--
```

6. Add the following files: **/etc/ppp/options.eth0**. The file context is shown below:

7. Set up DNS
   If you are using DNS servers supplied by your ISP, edit the file **/etc/resolv.conf** by adding the following lines of code:
   nameserver ip_addr_of_first_dns_server
   nameserver ip_addr_of_second_dns_server
   For example:
   nameserver 168.95.1.1
   nameserver 139.175.10.20
8. Use the following command to create a pppoe connection:
   pppd eth0
9. Type **ifconfig ppp0** to check if the connection is OK or has failed. If the connection is OK, you will see information about the ppp0 setting for the IP address. Use ping to test the IP.
10. If you want to disconnect it, use the kill command to kill the pppd process.

NFS (Network File System)

The Network File System (NFS) is used to mount a disk partition on a remote machine, as if it were on a local hard drive, allowing fast, seamless sharing of files across a network. NFS allows users to develop applications for the W406-LX, without worrying about the amount of disk space that will be available. The W406-LX supports NFS protocol for client.

NOTE Click on the following links for more information about NFS:
http://www.tldp.org/HOWTO/NFS-HOWTO/index.html

Setting up the W406-LX as an NFS Client

The following procedure is used to mount a remote NFS Server.

1. To know the NFS Server's shared directory.
2. Establish a mount point on the NFS Client site.
3. Mount the remote directory to a local directory.

```
#mkdir  –p  /home/nfs/public
#mount  –t  nfs  NFS_Server(IP):/directory  /mount/point
```

Example

```
#mount –t nfs 192.168.3.100:/home/public  /home/nfs/public
```

Mail

Smtpclient is a minimal SMTP client that takes an email message body and passes it on to an SMTP server. It is suitable for applications that use email to send alert messages or important logs to a specific user.

NOTE: Click on the following link for more information about smtpclient:http://www.engelschall.com/sw/smtpclient/

To send an email message, use the 'smtpclient' utility, which uses SMTP protocol. Type **`#smtpclient –help`** to see the help message.

Example:

```
smtpclient  –s  test –H Moxa –f  sender@company.com  –S  IP_address
receiver@company.com
<  mail-body-message
```

- **`-s:`** The mail subject.
- **`-f:`** Sender's mail address
- **`-S:`** SMTP server IP address

The last mail address **receiver@company.com** is the receiver's e-mail address.
mail-body-message is the mail content. The last line of the body of the message should contain ONLY the period '.' character.

You will need to add your hostname to the file **/etc/hosts**.

SNMP

The W406-LX has built-in SNMP V1 (Simple Network Management Protocol) agent software. It supports RFC1317 RS-232 like group and RFC 1213 MIB-II.

NOTE Click on the following links for more information about MIB II and RS-232 like groups:
http://www.faqs.org/rfcs/rfc1213.html
http://www.faqs.org/rfcs/rfc1317.html

→ W406-LX does NOT support SNMP trap.

Package Management—ipkg

ipkg is a very lightweight package management system. It also allows for dynamic installation/removal of packages on a running system. Because the disk space is limited, we provide these software as extension packages. You can use ipkg-cl to install or remove .ipk packages on the W406-LX.

Type '**upramdisk**' to get the free space ram disk to save the package. Check that you have enough free space

```
192.168.3.127 – PuTTY
root@Moxa:/bin# upramdisk
root@Moxa:/bin# df -h
Filesystem            Size      Used   Available  Use% Mounted on
Rootfs                8.6M      7.8M      888.0k  90%   /
/dev/root             8.6M      7.8M      888.0k  90%   /
/dev/ram3          1003.0k      9.0k      943.0k   1%   /dev
/dev/ram0           499.0k     18.0k      456.0k   4%   /var
/dev/mtdblock3        5.0M      3.8M      1.2M    76%   /tmp
/dev/mtdblock3        5.0M      3.8M      1.2M    76%   /home
/dev/mtdblock3        5.0M      3.8M      1.2M    76%   /etc
tmpfs                14.4M         0     14.4M     0%   /dev/shm
/dev/ram1            15.5M      1.0k     14.7M     0%   /var/ramdisk
root@Moxa:/bin#
```

To check that the **/dev/ram1** free space is greater than 3 MB.

Install an .ipk package via an .ipk file

Upload the .ipk package to the Moxa embedded computer,

```
192.168.3.120 – Putty
Moxa:~# scp /mnt/cdrom/utility_tools/libmysqlclient5_5.1.23_arm.ipk
192.168.3.127:/mnt/ramdisk/
```

Install the uploaded package

```
192.168.3.120 – Putty
~# ipkg-cl install /mnt/ramdisk/libmysqlclient5_5.1.23_arm.ipk
```

```
192.168.3.120 – Putty
Installing libmysqlclient5 (5.1.23) to root...
Stopping web server: apache.
ipkg: extract_archive: /CONTROL/: Read-only file system
ipkg: /CONTROL/postinst: No such file or directory
ipkg: /CONTROL/postrm: No such file or directory
ipkg: /CONTROL/prerm: No such file or directory
ipkg: /CONTROL/preinst: No such file or directory
ipkg: /CONTROL/control: No such file or directory
Configuring libmysqlclient5
Starting web server: apache.
Successfully terminated.
root@Moxa:/mnt/ramdisk#
```

Note if you would like to install php for Apache web server, you should install "mysqlclient" in advance.

List the installed packages

```
192.168.3.120 – Putty
root@Moxa:/mnt/ramdisk# ipkg-cl list_installed
libmysqlclient5 - 5.1.23 -
libphp5 - 5.2.5.1 -
Successfully terminated.
root@Moxa:/mnt/ramdisk#
```

Remove a package

```
192.168.3.120 – Putty
Moxa:~# ipkg-cl remove libphp5
```

OpenVPN

OpenVPN provides two types of tunnels for users to implement VPNS: **Routed IP Tunnels** and **Bridged Ethernet Tunnels**. To begin with, check to make sure that the system has a virtual device **/dev/net/tun**. If not, issue the following command:

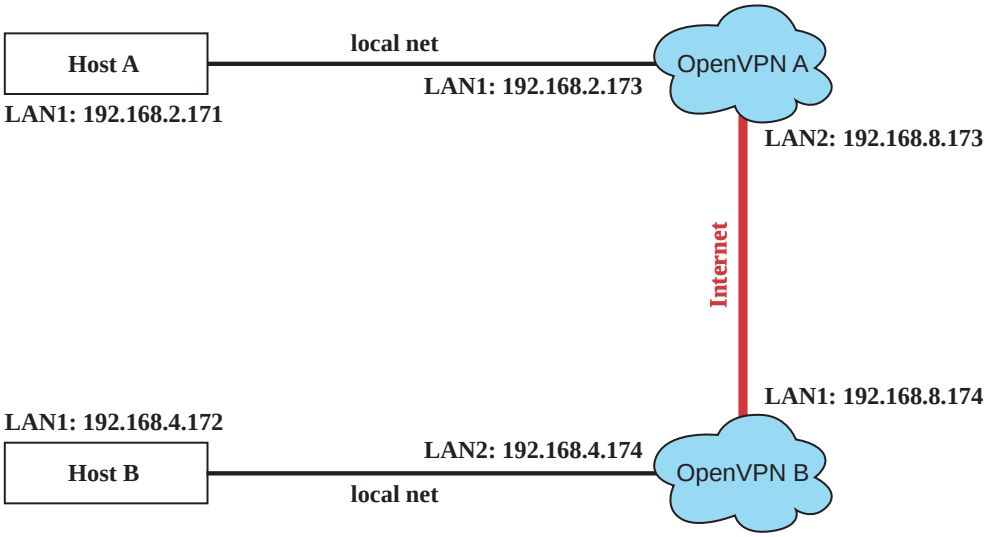
```
# mknod /dev/net/tun c 10 200
```

An Ethernet bridge is used to connect different Ethernet networks together. The Ethernets are bundled into one bigger, "logical" Ethernet. Each Ethernet corresponds to one physical interface (or port) that is connected to the bridge.

On each OpenVPN machine, you should generate a working directory, such as **/etc/openvpn**, where script files and key files reside. Once established, all operations will be performed in that directory.

Setup 1: Ethernet Bridging for Private Networks on Different Subnets

1. Set up four machines, as shown in the following diagram.



Host A (B) represents one of the machines that belongs to OpenVPN A (B). The two remote subnets are configured for a different range of IP addresses. When this setup is moved to a public network, the external interfaces of the OpenVPN machines should be configured for static IPs, or connect to another device (such as a firewall or DSL box) first.

```
# openvpn --genkey --secret secrouter.key
```

Copy the file that is generated to the OpenVPN machine.

2. Generate a script file named **openvpn-bridge** on each OpenVPN machine. This script reconfigures interface "eth1" as IP-less, creates logical bridge(s) and TAP interfaces, loads modules, enables IP forwarding, etc.

```
#--------------------------------Start----------------------------

#!/bin/sh

iface=eth1  # defines the internal interface
maxtap=`expr 1`# defines the number of tap devices. I.e., # of tunnels

IPADDR=
NETMASK=
BROADCAST=

# it is not a great idea but this system doesn't support
# /etc/sysconfig/network-scripts/ifcfg-eth1
ifcfg_vpn()
{
 while read f1 f2 f3 f4 r3
 do
  if [ "$f1" = "iface" -a "$f2" = "$iface" -a "$f3" = "inet" -a "$f4" = "static" ];then
   i=`expr 0`
   while :
   do
    if [ $i -gt 5 ]; then
     break
    fi
    i=`expr $i + 1`
    read f1 f2
    case "$f1" in
```

```
    address ) IPADDR=$f2
     ;;
    netmask ) NETMASK=$f2
     ;;
    broadcast ) BROADCAST=$f2
     ;;
   esac
  done
     break
 fi
done < /etc/network/interfaces
}

# get the ip address of the specified interface
mname=
module_up()
{
oIFS=$IFS
IFS='
'
FOUND="no"
for LINE in `lsmod`
do
 TOK=`echo $LINE | cut -d' ' -f1`
 if [ "$TOK" = "$mname" ]; then
  FOUND="yes";
  break;
 fi
done
IFS=$oIFS

if [ "$FOUND" = "no" ]; then
 modprobe $mname
fi
}

start()
{
ifcfg_vpn
if [ ! \( -d "/dev/net" \) ]; then
 mkdir /dev/net
fi

if [ ! \( -r "/dev/net/tun" \) ]; then
 # create a device file if there is none
 mknod /dev/net/tun c 10 200
fi

# load modules "tun" and "bridge"
mname=tun
module_up
mname=bridge
module_up
# create an ethernet bridge to connect tap devices, internal interface
brctl addbr br0
brctl addif br0 $iface
# the bridge receives data from any port and forwards it to other ports.

i=`expr 0`
while :
do
 # generate a tap0 interface on tun
 openvpn --mktun --dev tap${i}

 # connect tap device to the bridge
 brctl addif br0 tap${i}

 # null ip address of tap device
```

```
 ifconfig tap${i} 0.0.0.0 promisc up

 i=`expr $i + 1`
 if [ $i -ge $maxtap ]; then
  break
 fi
done

# null ip address of internal interface
ifconfig $iface 0.0.0.0 promisc up

# enable bridge ip
ifconfig br0 $IPADDR netmask $NETMASK broadcast $BROADCAST

ipf=/proc/sys/net/ipv4/ip_forward
# enable IP forwarding
echo 1 > $ipf
echo "ip forwarding enabled to"
cat $ipf
}

stop() {
echo "shutdown openvpn bridge."
ifcfg_vpn
i=`expr 0`
while :
do
 # disconnect tap device from the bridge
 brctl delif br0 tap${i}
 openvpn --rmtun --dev tap${i}

 i=`expr $i + 1`
 if [ $i -ge $maxtap ]; then
  break
 fi
done
brctl delif br0 $iface
brctl delbr br0
ifconfig br0 down
ifconfig $iface $IPADDR netmask $NETMASK broadcast $BROADCAST
killall -TERM openvpn
}

case "$1" in
start)
 start
 ;;
stop)
 stop
 ;;
restart)
 stop
 start
 ;;
*)
 echo "Usage: $0 [start|stop|restart]"
 exit 1
esac
exit 0
#--------------------------------- end ----------------------------
```

Create link symbols to enable this script at boot time:

```
# ln -s /etc/openvpn/openvpn-bridge /etc/rc.d/rc3.d/S32vpn-br # for example
# ln -s /etc/openvpn/openvpn-bridge /etc/rc.d/rc6.d/K32vpn-br # for example
```

3. Create a configuration file named **A-tap0-br.conf** and an executable script file named **A-tap0-br.sh** on OpenVPN A.

```
# point to the peer
remote 192.168.8.174
dev tap0
secret /etc/openvpn/secrouter.key
cipher DES-EDE3-CBC
auth MD5
tun-mtu 1500
tun-mtu-extra 64
ping 40
up /etc/openvpn/A-tap0-br.sh
```

```
#---------------------------------Start----------------------------
#!/bin/sh
# value after "-net" is the subnet behind the remote peer
route add -net 192.168.4.0 netmask 255.255.255.0 dev br0
#--------------------------------- end ----------------------------
```

Create a configuration file named **B-tap0-br.conf** and an executable script file named **B-tap0-br.sh** on OpenVPN B.

```
# point to the peer
remote 192.168.8.173
dev tap0
secret /etc/openvpn/secrouter.key
cipher DES-EDE3-CBC
auth MD5
tun-mtu 1500
tun-mtu-extra 64
ping 40
up /etc/openvpn/B-tap0-br.sh
```

```
#--------------------------------- Start----------------------------
#!/bin/sh
# value after "-net" is the subnet behind the remote peer
route add -net 192.168.2.0 netmask 255.255.255.0 dev br0
#--------------------------------- end ----------------------------
```

Note: Select cipher and authentication algorithms by specifying "cipher" and "auth". To see which algorithms are available, type:

```
# openvpn --show-ciphers
```

4. Start both of OpenVPN peers,

```
# openvpn --config A-tap0-br.conf&
# openvpn --config B-tap0-br.conf&
```

If you see the line "Peer Connection Initiated with 192.168.8.173:5000" on each machine, the connection between OpenVPN machines has been established successfully on UDP port 5000.

5. On each OpenVPN machine, check the routing table by typing the command:

```
# route
```

Destination	Gateway	Genmsk	Flags	Metric	Ref	Use	Iface
192.168.4.0	*	255.255.255.0	U	0	0	0	br0
192.168.2.0	*	255.255.255.0	U	0	0	0	br0
192.168.8.0	*	255.255.255.0	U	0	0	0	eth0

Interface **eth1** is connected to the bridging interface **br0**, to which device **tap0** also connects, whereas the virtual device **tun** sits on top of **tap0**. This ensures that all traffic from internal networks connected to interface **eth1** that come to this bridge write to the TAP/TUN device that the OpenVPN program monitors. Once the OpenVPN program detects traffic on the virtual device, it sends the traffic to its peer.

6. To create an indirect connection to Host B from Host A, you need to add the following routing item:

   ```
   route add –net 192.168.4.0 netmask 255.255.255.0 dev eth0
   ```

   To create an indirect connection to Host A from Host B, you need to add the following routing item:

   ```
   route add –net 192.168.2.0 netmask 255.255.255.0 dev eth0
   ```

   Now ping Host B from Host A by typing:

   ```
   ping 192.168.4.174
   ```

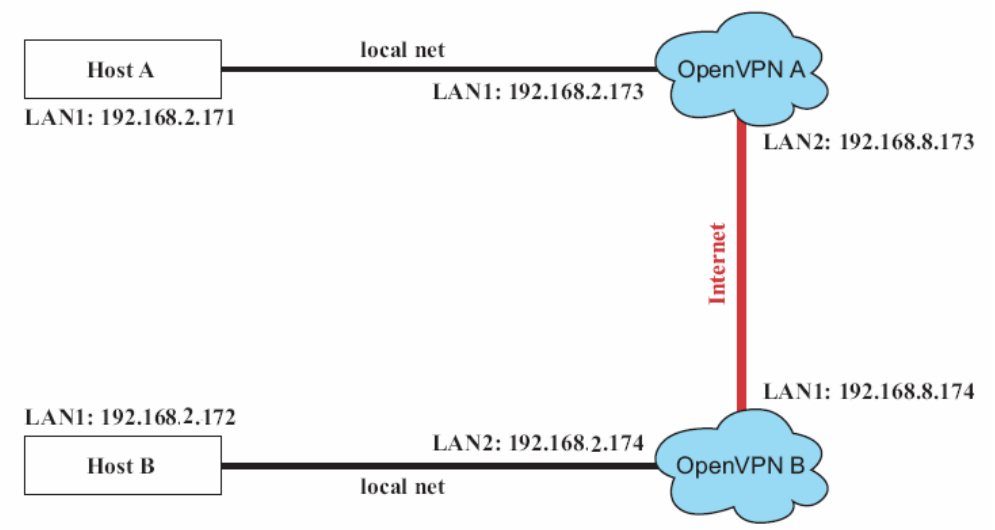
   A successful ping indicates that you have created a VPN system that only allows authorized users from one internal network to access users at the remote site. For this system, all data is transmitted by UDP packets on port 5000 between OpenVPN peers.

7. To shut down OpenVPN programs, type the command:

   ```
   # killall -TERM openvpn
   ```

Setup 2: Ethernet Bridging for Private Networks on the Same Subnet

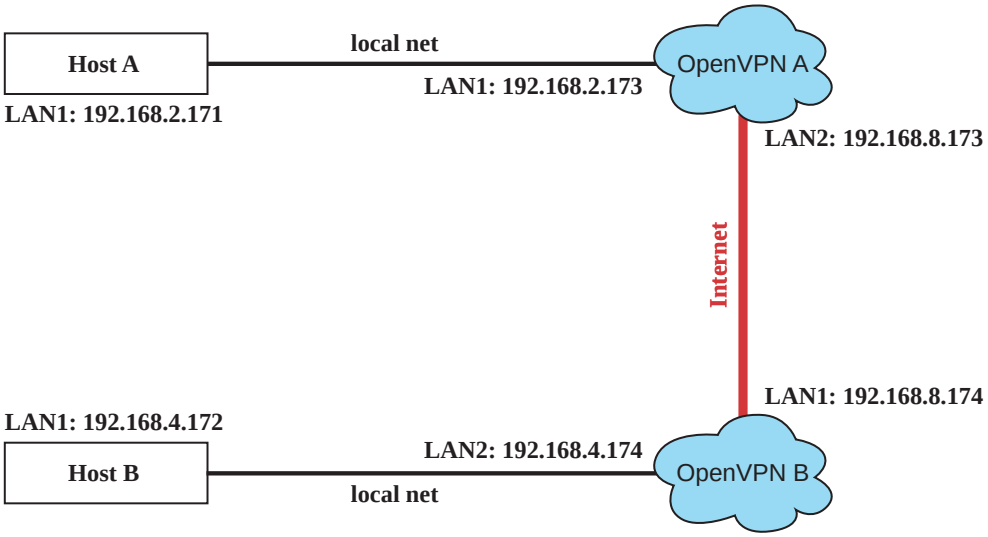
1. Set up four machines as shown in the following diagram:



2. The configuration procedure is almost the same as for the previous example. The only difference is that you will need to indicate the **#up** parameter. "/etc/openvpn/A-tap0-br.conf" and "/etc/openvpn/B-tap0-br.conf".

Setup 3: Routed IP

1. Set up the four machines as shown in the following diagram:



2. Create a configuration file named "A-tun.conf" and an executable script file named "A-tun.sh".

```
# point to the peer
remote 192.168.8.174
dev tun
secret /etc/openvpn/secrouter.key
cipher DES-EDE3-CBC
auth MD5
tun-mtu 1500
tun-mtu-extra 64
ping 40
ifconfig 192.168.2.173 192.168.4.174
up /etc/openvpn/A-tun.sh

#------------------------------- Start----------------------------
#!/bin/sh
# value after "-net" is the subnet behind the remote peer
route add -net 192.168.4.0 netmask 255.255.255.0 gw $5
#------------------------------- end ----------------------------
```

Create a configuration file named **B-tun.conf** and an executable script file named **B-tun.sh** on OpenVPN B:

```
remote 192.168.8.173
dev tun
secret /etc/openvpn/secrouter.key
cipher DES-EDE3-CBC
auth MD5
tun-mtu 1500
tun-mtu-extra 64
ping 40
ifconfig 192.168.4.174 192.168.2.173
up /etc/openvpn/B-tun.sh

#------------------------------- Start----------------------------
#!/bin/sh
# value after "-net" is the subnet behind the remote peer
route add -net 192.168.2.0 netmask 255.255.255.0 gw $5
#------------------------------- end ----------------------------
```

Note that the parameter "ifconfig" defines the first argument as the local internal interface and the second argument as the internal interface at the remote peer.

Note that **$5** is the argument that the OpenVPN program passes to the script file. Its value is the second argument of **ifconfig** in the configuration file.

3. Check the routing table after you run the OpenVPN programs, by typing the command:

```
# route
```

Destination	Gateway	Genmsk	Flags	Metric	Ref	Use	Iface
192.168.4.174	*	255.255.255.255	UH	0	0	0	tun0
192.168.4.0	192.168.4.174	255.255.255.0	UG	0	0	0	tun0
192.168.2.0	*	255.255.255.0	U	0	0	0	eth1
192.168.8.0	*	255.255.255.0	U	0	0	0	eth0

5

Development Tool Chains

This chapter describes how to install a tool chain in the host computer that you use to develop your applications. In addition, the process of performing cross-platform development and debugging are also introduced. For clarity, the W406-LX embedded computer is called a target computer.

The following functions are covered in this chapter:

- **Linux Tool Chain**
  - Steps for Installing the Linux Tool Chain
  - Compilation for Applications
  - On-Line Debugging with GDB

Linux Tool Chain

The Linux tool chain contains a suite of cross compilers and other tools, as well as the libraries and header files that are necessary to compile your applications. These tool chain components must be installed in your host computer (PC) running Linux. We have confirmed that the following Linux distributions can be used to install the tool chain.

Fedora 7, Debian 4

Steps for Installing the Linux Tool Chain

The tool chain needs about 1 GB of hard disk space. To install it, follow the steps.

1. Insert the package CD into your PC and then issue the following commands:

   ```
   #mount /dev/cdrom /mnt/cdrom
   #sh /mnt/cdrom/toolchain/arm-linux_2.1.sh
   ```

2. Wait for the installation process to complete. This should take a few minutes.
3. Add the directory **/usr/local/arm-linux/bin** to your path. You can do this for the current login by issuing the following commands:

   ```
   #export PATH="/usr/local/arm-linux/bin:$PATH"
   ```

   Alternatively, you can add the same commands to **$HOME/.bash_profile** to make it effective for all login sessions.

Compilation for Applications

To compile a simple C application, use the cross compiler instead of the regular compiler:

```
#arm-linux-gcc  –o example –Wall –g –O2 example.c
#arm-linux-strip  –s example
#arm-linux-gcc  -ggdb –o example-debug example.c
```

Most of the cross compiler tools are the same as their native compiler counterparts, but with an additional prefix that specifies the target system. In the case of x86 environments, the prefix is **`i386-linux-`** and in the case of W406-LX ARM boards, it is **`arm-linux-`**.

For example, the native C compiler is **`gcc`** and the cross C compiler for ARM in the W406-LX is **`arm-linux-gcc.`**

The following cross compiler tools are provided with a prefix "arm-linux-".

ar	Manages archives (static libraries)
as	Assembler
c++, g++	C++ compiler
cpp	C preprocessor
gcc	C compiler
gdb	Debugger
ld	Linker
nm	Lists symbols from object files
objcopy	Copies and translates object files
objdump	Displays information about object files
ranlib	Generates indexes to archives (static libraries)
readelf	Displays information about ELF files
size	Lists object file section sizes
strings	Prints strings of printable characters from files (usually object files)
strip	Removes symbols and sections from object files (usually debugging information)

On-Line Debugging with GDB

The tool chain also provides an on-line debugging mechanism to help you develop your program. Before performing a debugging session, add the option **-ggdb** to compile the program. A debugging session runs on a client-server architecture on which the server **`gdbserver`** is installed in the target computer and the client **ddd** is installed in the host computer. We'll asuumne that you have uploaded a program named **hello-debug** to the target computer and started debugging the program.

1. Log on to the target computer and run the debugging server program.

   ```
   #gdbserver 192.168.4.142:2000 hello-debug
   Process hello-debug created; pid=38
   ```

   The debugging server listens for connections at network port 2000 from the network interface 192.168.4.142. The name of the program to be debugged follows these parameters. For a program requiring arguments, add the arguments behind the program name.

2. In the host computer, change the directory to where the program source resides**.**

   ```
   cd /my_work_directory/myfilesystem/testprograms
   ```

3. Execute the client program.

   ```
   #ddd --debugger arm-linux-gdb hello-debug &
   ```

4. Enter the following command at the GDB, DDD command prompt.

   ```
   Target remote 192.168.4.99:2000
   ```

   The command produces a line of output on the target console, similar to the following.

   ```
   Remote debugging using 192.168.4.99:2000
   ```

   192.168.4.99 is the machine's IP address, and 2000 is the port number. You can now begin debugging in the host environment using the interface provided by DDD.

5. Set a break point on main function by double clicking, or by entering **`b main`** on the command line.

6. Click the **cont** button.

6

Programmer's Guide

This chapter includes important information for programmers.

The following functions are covered in this chapter:

- **Flash Memory Map**
- **Device API**
- **RTC (Real Time Clock)**
- **Buzzer**
- **UART**
- **Digital I/O**
- **C Library**

Flash Memory Map

Partition sizes are hard coded into the kernel binary. To change the partition sizes, you will need to rebuild the kernel. The flash memory map is shown in the following table.

Address	Size	Contents
0x00000000 – 0x00060000	384 KB	Boot Loader—Read ONLY
0x00060000 – 0x00260000	2 MB	Kernel object code—Read ONLY
0x00260000 – 0x00b00000	8.6 MB	Root file system (JFFS2) —Read ONLY
0x00b00000 – 0x01000000	5 MB	User directory (JFFS2) —Read/Write

If the user file system is incorrect, the kernel will change the root file system to the kernel and use the default Moxa file system. To finish the boot process, run the init program.

NOTE
1. The user file system is a complete file system. Users can create and delete directories and files (including source code and executable files) as needed.
2. Users can create the user file system on the PC host or target platform, and then copy it to the W406-LX.

Device API

The W406-LX supports control devices with the **ioctl** system API. You will need to **`include <moxadevice.h>`**, and use the following **ioctl** function.

```
int ioctl(int d, int request,…);
 Input: int d  - open device node return file handle
        int request – argument in or out
```

Use the desktop Linux's man page for detailed documentation:

```
#man ioctl
```

RTC (Real Time Clock)

The device node is located at **/dev/rtc**. The W406-LX supports Linux standard simple RTC control. You must **`include <linux/rtc.h>`**.

1. Function: RTC_RD_TIME

   ```
   int ioctl(fd, RTC_RD_TIME, struct rtc_time *time);
   ```

   Description: read time information from RTC. It will return the value on argument 3.

2. Function: RTC_SET_TIME

   ```
   int ioctl(fd, RTC_SET_TIME, struct rtc_time *time);
   ```

   Description: set RTC time. Argument 3 will be passed to RTC.

Buzzer

The device node is located at **/dev/console**. The W406-LX supports Linux standard buzzer control, with the W406-LX's buzzer running at a fixed frequency of 100 Hz. You must **include <sys/kd.h>**.

Function: KDMKTONE

```
ioctl(fd, KDMKTONE, unsigned int arg);
```

Description: The buzzer's behavior is determined by the argument **arg**. The "high word" part of the argument gives the length of time the buzzer will sound, and the "low word" part gives the frequency.

The buzzer's on/off behavior is controlled by software. If you call the "ioctl" function, you MUST set the frequency at 100 Hz. If you use a different frequency, the system could crash.

UART

The normal tty device node is located at **/dev/ttyM0 … ttyM3**.

The W406-LX supports Linux standard termios control. The Moxa UART Device API allows you to configure ttyM0 to ttyM3 as RS-232, RS-422, 4-wire RS-485, or 2-wire RS-485. W406-LX supports RS-232, RS-422, 2-wire RS-485, and 4-wire RS485.

You must **include <moxadevice.h>**.

```
#define RS232_MODE   0
#define RS485_2WIRE_MODE 1
#define RS422_MODE   2
#define RS485_4WIRE_MODE 3
```

1. Function: MOXA_SET_OP_MODE

   ```
   int ioctl(fd, MOXA_SET_OP_MODE, &mode)
   ```

   Description
   Set the interface mode. Argument 3 mode will pass to the UART device driver and change it.

2. Function: MOXA_GET_OP_MODE

   ```
   int ioctl(fd, MOXA_GET_OP_MODE, &mode)
   ```

   Description
   Get the interface mode. Argument 3 mode will return the interface mode.

There are two Moxa private ioctl commands for setting up special baudrates.

Function: MOXA_SET_SPECIAL_BAUD_RATE
Function: MOXA_GET_SPECIAL_BAUD_RATE

If you use this ioctl to set a special baudrate, the termios cflag will be B4000000, in which case the B4000000 define will be different. If the baudrate you get from termios (or from calling tcgetattr()) is B4000000, you must call ioctl with MOXA_GET_SPECIAL_BAUD_RATE to get the actual baudrate.

Example to set the baudrate

```
#include <moxadevice.h>
#include <termios.h>
struct termios term;
int  fd, speed;
fd = open("/dev/ttyM0", O_RDWR);
tcgetattr(fd, &term);
term.c_cflag &= ~(CBAUD | CBAUDEX);
term.c_cflag |= B4000000;
tcsetattr(fd, TCSANOW, &term);
speed = 500000;
ioctl(fd, MOXA_SET_SPECIAL_BAUD_RATE, &speed);
```

Example to get the baudrate

```
 #include <moxadevice.h>
 #include <termios.h>
 struct termios term;
 int  fd, speed;
 fd = open("/dev/ttyM0", O_RDWR);
 tcgetattr(fd, &term);
if ( (term.c_cflag & (CBAUD|CBAUDEX)) != B4000000 ) {
  // follow the standard termios baud rate define
} else {
  ioctl(fd, MOXA_GET_SPECIAL_BAUD_RATE, &speed);
}
```

Baudrate inaccuracy

Divisor = 921600/Target Baud Rate. (Only Integer part)
ENUM = 8 * (921600/Target - Divisor) (Round up or down)
Inaccuracy =((Target Baud Rate – 921600/(Divisor + (ENUM/8))) / Target Baud Rate)* 100%
E.g.,
To calculate 500000 bps
Divisor = 1, ENUM = 7,
Inaccuracy = 1.7%
* Inaccuracy should be less than 2% for work reliably.

Special Note

1. If the target baudrate is not a special baudrate (e.g. 50, 75, 110, 134, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600), the termios cflag will be set to the same flag.
2. If you use stty to get the serial information, you will get speed equal to 0.

Digital I/O

Digital Output channels can be set to high or low. The channels are controlled by the function call **set_dout_state( )**. The digital input channels can be used to detect the state change of the digital input signal. The DI channels can also be used to detect whether or not the state of a digital signal changes during a fixed period of time. This can be done by the function call, **set_din_event( )**.

Moxa provides 5 function calls to handle the digital I/O state change and event handling.

Application Programming Interface

Return error code definitions:

```
#define DIO_ERROR_PORT -1 // no such port
#define DIO_ERROR_MODE -2 // no such mode or state
#define DIO_ERROR_CONTROL -3  // open or ioctl fail
#define DIO_ERROR_DURATION -4  // The value of duration is not 0 or not in the range, 40 <= duration <= 3600000 milliseconds (1 hour)
#define DIO_ERROR_DURATION_20MS -5 // The value of duration must be a multiple of 20 ms
#define DIO_OK 0
```

The definition for DIN and DOUT:

```
#define DIO_HIGH 1
#define DIO_LOW 0
```

int set_dout_state(int doport, int state)

Description: To set the DOUT port to high or low state.

Input: int doport - which DOUT port you want to set. Port starts from 0 to 3.

int state - to set high or low state; DIO_HIGH (1) for high, DIO_LOW (0) for low.

Output: none.

Return: reference the error code.

*int get_din_state(int diport, int *state)*

Description: To get the DIN port state.

Input: int diport - get the current state of which DIN port. Port numbering is from 0 to 3.

int *state - save the current state.

Output: state - DIO_HIGH (1) for high, DIO_LOW (0) for low.

Return: reference the error code.

*int get_dout_state(int doport, int *state)*

Description: To get the DOUT port state.

Input: int doport - get the current state of which DOUT port.

int *state - save the current state.

Output: state - DIO_HIGH (1) for high, DIO_LOW (0) for low.

Return: reference the error code.

*int set_din_event(int diport, void (*func)(int diport), int mode, long int duration)*

Description: Set the event for DIN when the state is changed from high to low or from low to high.

Input: int diport - the port that will be used to detect the DIN event.

Port numbering is from 0 to 3.

void (*func) (int diport) - Not NULL

> Returns the call back function. When the event occurs, the call back function will be invoked.

NULL

> Clears this event

int mode - DIN_EVENT_HIGH_TO_LOW

(1): from high to low

DIN_EVENT_LOW_TO_HIGH

(0): from low to high

DIN_EVENT_CLEAR

(-1): clear this event

unsigned long duration - 0: detect the din event > DIN_EVENT_HIGH_TO_LOW or DIN_EVENT_LOW_TO_HIGH> without duration

- Not 0

> detect the din event

DIN_EVENT_HIGH_TO_LOW or

DIN_EVENT_LOW_TO_HIGH with duration.

The value of "duration" must be a multiple of 20 milliseconds.

The range of "duration" is 0, or 40 <= duration <= 3600000 milliseconds.

The error of the measurement is 24 ms. For example, if the DIN duration is 200 ms, this event will be generated when the DIN pin stays in the same state for a time between 176 ms and 200 ms.

Output: none.

Return: reference the error code.

`int get_din_event(int diport, int *mode, long int *duration)`

Description: To retrieve the DIN event configuration, including mode

(DIN_EVENT_HIGH_TO_LOW or DIN_EVENT_LOW_TO_HIGH), and the value of "duration."

Input: **int diport** - which DIN port you want to retrieve.

The port whose din event setting we wish to retrieve

int *mode - save which event is set.

unsigned long *duration - the duration of the DIN port is kept in high or low state.

- return to the current duration value of diport

Output: **mode** DIN_EVENT_HIGH_TO_LOW

(1): from high to low

DIN_EVENT_LOW_TO_HIGH(0): from low to high

DIN_EVENT_CLEAR(-1): clear this event **duration**

The value of duration should be 0 or 40 <= duration <= 3600000 milliseconds.

Return: reference the error code.

Special Note

Don't forget to link the library **libmoxalib** for DI/DO programming, and also include the header file **moxadevice.h**. The DI/DO library only can be used by one program at a time.

Examples

DIO Program Source Code File Example

File Name: tdio.c

Description: The program indicates to connect DO1 to DI1, change the digital output state to high or low by manual input, then detect and count the state changed events from DI1.

```
#include <stdio.h>
#include <stdlib.h>
#include <moxadevice.h>
#include <fcntl.h>
#ifdef DEBUG
#define dbg_printf(x...) printf(x)
#else
#define dbg_printf(x...)
#endif
#define MIN_DURATION 40
static char *DataString[2]={"Low ", "High "};
static void hightolowevent(int diport)
{
printf("\nDIN port %d high to low.\n", diport);
}
static void lowtohighevent(int diport)
{
printf("\nDIN port %d low to high.\n", diport);
}
int main(int argc, char * argv[])
{
int i, j, state, retval;
unsigned long duration;
while( 1 ) {
printf("\nSelect a number of menu, other key to exit. \n\
1. set high to low event \n\
```

```
2. get now data. \n\
3. set low to high event \n\
4. clear event \n\
5. set high data. \n\
6. set low data. \n\
7. quit \n\
8. show event and duration \n\
Choose : ");
retval =0;
scanf("%d", &i);
if ( i == 1 ) { // set high to low event
printf("Please keyin the DIN number : ");
scanf("%d", &i);
printf("Please input the DIN duration, this minimun value must be over %d : ", MIN_DURATION);
scanf("%lu", &duration);
retval=set_din_event(i, hightolowevent, DIN_EVENT_HIGH_TO_LOW, duration);
} else if ( i == 2 ) { // get now data
printf("DIN data : ");
for ( j=0; j<4; j++ ) {
get_din_state(j, &state);
printf("%s", DataString[state]);
}
printf("\n");
printf("DOUT data : ");
for ( j=0; j<MAX_DOUT_PORT; j++ ) {
get_dout_state(j, &state);
printf("%s", DataString[state]);
}
printf("\n");
} else if ( i == 3 ) { // set low to high event
printf("Please keyin the DIN number : ");
scanf("%d", &i);
printf("Please input the DIN duration, this minimun value must be over %d :", MIN_DURATION);
scanf("%lu", &duration);
retval = set_din_event(i, lowtohighevent, DIN_EVENT_LOW_TO_HIGH, duration);
} else if ( i == 4 ) { // clear event
printf("Please keyin the DIN number : ");
scanf("%d", &i);
retval=set_din_event(i, NULL, DIN_EVENT_CLEAR, 0);
} else if ( i == 5 ) { // set high data
printf("Please keyin the DOUT number : ");
```

```
scanf("%d", &i);
retval=set_dout_state(i, 1);
} else if ( i == 6 ) { // set low data
printf("Please keyin the DOUT number : ");
scanf("%d", &i);
retval=set_dout_state(i, 0);
} else if ( i == 7 ) { // quit
break;
} else if ( i == 8 ) { // show event and duration
printf("Event:\n");
for ( j=0; j<MAX_DOUT_PORT; j++ ) {
retval=get_din_event(j, &i, &duration);
switch ( i ) {
case DIN_EVENT_HIGH_TO_LOW :
printf("(htl,%lu)", duration);
break;
case DIN_EVENT_LOW_TO_HIGH :
printf("(lth,%lu)", duration);
break;
case DIN_EVENT_CLEAR :
printf("(clr,%lu)", duration);
break;
default :
printf("err " );
break;
}
}
printf("\n");
} else {
printf("Select error, please select again !\n");
}
switch(retval) {
case DIO_ERROR_PORT:
printf("DIO error port\n");
break;
case DIO_ERROR_MODE:
printf("DIO error mode\n");
break;
case DIO_ERROR_CONTROL:
printf("DIO error control\n");
break;
```

```
case DIO_ERROR_DURATION:
printf("DIO error duratoin\n");
case DIO_ERROR_DURATION_20MS:
printf("DIO error! The duratoin is not a multiple of 20 ms\n");
break;
}
}
return 0;
}
```

DIO Program Make File Example

```
FNAME=tdio
CC=arm-linux-gcc
STRIP=arm-linux-strip
release:
$(CC) -o $(FNAME) $(FNAME).c -lmoxalib -lpthread
$(STRIP) -s $(FNAME)
debug:
$(CC) -DDEBUG -o $(FNAME)-dbg $(FNAME).cxx -lmoxalib -lpthread
clean:
/bin/rm -f $(FNAME) $(FNAME)-dbg *.o
```

C Library

GPRS/SIM/SMS

The definition header file includes the entire library API; you can find it in the path "/usr/local/arm-linux/include/libsms".

Opens a cellular modem handle for later use.
unsigned int cellular_modem_open(void);
Inputs: None
Return Values: pointer to a cellular modem handle. Return 0 on failure.
Remark: Every cellular modem API needs the cellular modem handle parameter, so you must use the function first before you program them.

Closes a cellular modem handle.
void cellular_modem_close(unsigned int fd);
Inputs: <fd> the handle
Return Values: None
Remark: You must release the cellular modem handle resource if you don't need to use cellular modem APIs later.

Sends an AT command to a cellular modem and waits for a reply.
int cellular_modem_send_cmd(unsigned int fd, char *at_cmd, char *recv, int recv_size, int timeout);
Inputs: <fd> the cellular modem <at_cmd> the AT command <recv_size> maximum size of the buffer that stores replied data <timeout> timeout in milliseconds if no response. Outpus: <recv> point to buffer that stores the reply
Return Values: the number of received data, -1 indicates failure.
Remark: Generally, you can set the timeout to be 1000~2000 milliseconds, but if you call the function with "AT^SMGL=ALL" command. We suggest you set the timeout greater than 10000, because listing all of the SMS messages requires more time.

Gets the signal strength of the GPRS modem.
int cellular_modem_gprs_get_signal_strength(unsigned int fd);
Inputs: <fd> the cellular modem Outpus: <recv> point to buffer that stores the reply
Return Values: 1 to 99 on success, otherwise the function fails
Remark: It is suggested to call this function periodically.

Establishes a GPRS connection to the ISP service provider.
int cellular_modem_gprs_establish_connection(unsigned int fd, char *user, char *password);
Inputs: <fd> the cellular modem <user> point to the user id, null indicates empty userid. <password> point to the user password, null indicates empty password.
Return Values: 0 on success, otherwise, the function fails
Remark:

Aborts a GPRS connection.
int cellular_modem_gprs_abort_connection(unsigned int fd);
Inputs: <fd> the cellular modem
Return Values: 0 on success, otherwise, the function fails
Remark:

Checks the status of a GPRS connection.
int cellular_modem_gprs_check_connection_status(unsigned int fd);
Inputs: <fd> the cellular modem
Return Values: 0 indictes the connection is on. otherwise, it is disconnected
Remark:

Diagnoses the status of a GPRS connection and the status of the SIM card.
unsigned int cellular_modem_gprs_diagnose_status(unsigned int fd);
Inputs: <fd> the cellular modem
Return Values: 0 indictes no error. otherwise, a 32-bit number indicating a combination of errors
Remark: define GPRS errors, of which each stands on one of a 32-bit number #define GPRS_ERROR_BAUDRATE_COM3 (1<<0) #define GPRS_ERROR_BAUDRATE_COM4 (1<<1) #define GPRS_ERROR_FLOWCONTROL (1<<2) #define GPRS_ERROR_PINCODE (1<<3) #define GPRS_ERROR_TEMPERATURE (1<<4) #define GPRS_ERROR_SIGNAL_STRENGTH (1<<5) #define GPRS_ERROR_RADIOBAND (1<<6) #define GPRS_ERROR_MODULE (1<<7) If the Cellular modem temperature greater than 88 degree or less than -35 degree, the function will return with GPRS_ERROR_TEMPERATURE.

Sets the storage base of SIM messages.
int cellular_modem_sms_set_storage_base(unsigned int fd, int mode);
Inputs: <fd> the cellular modem <mode> 0: on SIM card, 1: on modem module, 2: on both
Return Values: 0 on success, otherwise, the function fails
Remark:

Gets the storage base of SIM messages.
int cellular_modem_sms_get_storage_base(unsigned int fd);
Inputs: <fd> the cellular modem
Return Values: 0: on SIM card, 1: on modem module, 2: on both, otherwise, the function fails
Remark:

Gets the number of stored messages allowed out of the maximum space.
int cellular_modem_sms_get_message_count(unsigned int fd, int *maximum);
Inputs: <fd> the cellular modem Outputs: <maximum> pointer to the maximum number of messages allowed
Return Values: The number of stored messages, otherwise, a negative value indicates a failure
Remark:

Sends a SMS message to a specific phone number.
int cellular_modem_sms_send_message(unsigned int fd, unsigned int msg_mode, SMSMSG *psms);
Inputs: <fd> the cellular modem <msg_mode> 0: message in text, 1: message in PDU <psms> point to the message
Return Values: 0 on success, otherwise, the function fails
Remark: #define MAX_SMS_BYTES 512 typedef struct _SMSMSG { unsigned int been_read; char msg_date[12]; char msg_time[20]; char phone_number[20]; unsigned int msg_length; char msg_text[MAX_SMS_BYTES]; } SMSMSG, *PSMSMSG; If you like to use PDU mode to send your SMS message, you must construct your PDU data into the "SMSMSG.msg_text" field with exact length "SMSMSG.msg_length".

Receives an indexed SMS message.
int cellular_modem_sms_recv_message(unsigned int fd, int index, unsigned int msg_mode, SMSMSG *psms);
Inputs: <fd> the cellular modem <index> the index to the message pool <msg_mode> 0: message in text, 1: message in PDU <psms> point to the message
Return Values: 0 on success, otherwise, the function fails
Remark: #define MAX_SMS_BYTES 512 typedef struct _SMSMSG { unsigned int been_read; char msg_date[12]; char msg_time[20]; char phone_number[20]; unsigned int msg_length; char msg_text[MAX_SMS_BYTES]; } SMSMSG, *PSMSMSG; If you like to use PDU mode to receive your SMS message, you must destruct the "SMSMSG.msg_text" field to extract the message body.

Deletes an indexed SMS message.
int cellular_modem_sms_delete_message(unsigned int fd, int index);
Inputs: <fd> the cellular modem <index> the index to the message pool
Return Values: 0 on success, otherwise, the function fails
Remark:

Gets the SIM card status.
int cellular_modem_sim_get_sim_card_status(unsigned int fd);
Inputs: <fd> the cellular modem
Return Values: 0 : ready, okay to use 1 : no sim card, (or loose) 2 : PIN, wait for the pin code for authentication 3 : PUK, three times of wrong pin codes otherwise, the function fails
Remark:

When the SIM card status is set to PIN (2), this function retrieves the available PIN code attempt count. If the SIM card status is set to PUK (3), this function gets the available PUK code attempt count.
int cellular_modem_sim_get_pin_attempt_count(unsigned int fd);
Inputs: <fd> the cellular modem
Return Values: The attempted count left of PIN/PUK code authentication. otherwise, a negative value indicates a failure
Remark:

When the SIM card status is set to PIN (2), this function authenticates a PIN code. If the correct code is entered the status will be set back to ready (0).
int cellular_modem_sim_authenticate_pin_code(unsigned int fd, char *pin_code);
Inputs: <fd> the cellular modem <pin_code> point to the PIN code
Return Values: 0 on success, otherwise, the function fails
Remark:

When the SIM card status is PUK (3), this function changes the status to PIN (2). If this fails, the SIM card will be locked.
int cellular_modem_sim_unlock_pin_code(unsigned int fd, char *passwd, char *new_pin_code);
Inputs: <fd> the cellular modem <passwd> point to the PUK passwd code <new_pin_code> point to a new PIN code
Return Values: 0 on success, otherwise, the function fails
Remark:

Gets the PIN code enable status of the SIM card.
int cellular_modem_sim_get_pin_enable_status (unsigned int fd);
Inputs: <fd> the cellular modem
Return Values: 0 : PIN code disabled 1 : PIN code enabled otherwise, the function fails
Remark:

When the SIM card status is ready (0) and the PIN code is enabled, this function assigns a PIN code to the SIM card.
int cellular_modem_sim_assign_pin_code(unsigned int fd, char *old_pin_code, char *new_pin_code);
Inputs: <fd> the cellular modem <old_pin_code> point to the old PIN code <new_pin_code> point to the new PIN code
Return Values: 0 on success, otherwise, the function fails
Remark:

When the SIM card status is ready (0), this function enables or disables PIN code authentication.
int cellular_modem_sim_enable_pin_code(unsigned int fd, char *pin_code, int enable);
Inputs: <fd> the cellular modem <pin_code> point to the PIN code password <enable> 1: enable PIN code, 0: disable PIN code
Return Values: 0 on success, otherwise, the function fails
Remark:

Get the modem module temperature.
int cellular_modem_gprs_get_module_temperature(unsigned int fd)
Inputs: <fd> the cellular modem
Return Values: the tempture of GPRS module
Remark:

UART

Gets the UART interface.
DWORD uart_getmode(int port);
Inputs: <port> the serial port number.
Return Values: 0 : RS-232 1 : RS485-2W 2 : RS422 3 : RS485-4W otherwise, the function fails
Remark: For example, user **uart_getmode(2)** to retrieve the interface of **COM2:**

Sets the UART interface.
BOOL uart_setmode(int port, int mode);
Inputs: <port> the serial port number. <mode> the interface parameter. 0 : RS-232 1 : RS485-2W 2 : RS422 3 : RS485-4W
Return Values: TRUE indicates success, FALSE indicates failed.
Remark: For example, user **uart_getmode(2)** to retrieve the interface of **COM2:**

DIO

Opens a DIO handle for later use.
HANDLE mxdio_init(void);
Inputs: none
Return Values: pointer to a DIO handle. Return 0 on failure.
Remark: Every DIO API needs the handle parameter, so you must use the function first before you program them.

Closes the DIO handle.
void mxdio_stop(HANDLE hDIO);
Inputs: <hDIO> the DIO handle
Return Values: None
Remark:

Sets one of the DOUT outputs.
int mxdio_set_dout(HANDLE hDIO, unsigned int port, unsigned int data);
Inputs: <hDIO> the DIO handle <port> the port index, from 0 to 3 mapping to DO0~DO3 <data> 1: HIGH, 0: LOW
Return Values: 0 on success, otherwise, the function fails
Remark:

Gets one of the DIN inputs.
int mxdio_get_din(HANDLE hDIO, unsigned int port);
Inputs: <hDIO> the DIO handle <port> the port index, from 0 to 3 mapping to DI0~DI3
Return Values: 1 indicates HIGH, 0 indicates LOW
Remark:

Gets one of DOUT outputs.
int mxdio_get_dout(HANDLE handle_dio,unsigned int port);
Inputs: <hDIO> the DIO handle <port> the port index, from 0 to 3 mapping to DO0~DO3
Return Values: 1 indicates HIGH, 0 indicates LOW
Remark:

Watchdog

Opens a watchdog handle for later use.
HANDLE watchdog_init(DWORD dwRefreshPeriod);
Inputs: <dwRefreshPeriod> the watchdog refresh time interval in milliseconds..
Return Values: the watchdog handle, INVALID_HANDLE_VALUE indicates failure.
Remark: After calling the watchdog_init(), you must call watchdog_refresh() in the specified time(dwRefreshPeriod) or the system will be triggered rebooting.

Watchdog refresh function call.
BOOL watchdog_refresh(HANDLE hWdg, DWORD dwRefreshPeriod);
Inputs: <hWdg> the watchdog handle from watchdog_init() returned
Return Values: TRUE indicates the watchdog refresh succeed, FALSE indicates refresh failure.
Remark:

Closes the watchdog handle.
BOOL watchdog_release(HANDLE hWdg);
Inputs: <hWdg> the watchdog handle watchdog_init() returned
Return Values: TRUE indicates the watchdog refresh succeed, FALSE indicates refresh failure.
Remark:

Buzzer

Turns on the buzzer.
void mxbeep_on(void);
Inputs: None
Return Values: None
Remark:

Turns off the buzzer.
void mxbeep_off(void);
Inputs: None
Return Values: None
Remark:

A. **Installing the "libsms" library**

To use this library, you must have the toolchain installed. The library will be installed during the toolchain installation process. Refer to the **Installing the Tool Chain (Linux)** section.

B. **Building the example "egprscmd"**

Copy the example source to your linux host,

debian:/cp –r /media/cdrom1/example/W406_gprs_utility/home/work/egprscmd

debian:/cd /home/work/W406_gprs_utility

debian:/home/work/W406_gprs_utility# make

arm-linux-gcc -g -O2 -I/usr/local/arm-linux/include/libsms -c main.c

arm-linux-gcc -g -O2 -I/usr/local/arm-linux/include/libsms -c fn.c

arm-linux-gcc -g -O2 -I/usr/local/arm-linux/include/libsms -lsms -o egprscmd main.o fn.o -lsms

debian:/home/work/W406_gprs_utility#

7

Software Lock

"Software Lock" is an innovative technology developed by the Moxa engineering force. It can be adopted by a system integrator or developer to protect his applications from being copied. An applicaion is compiled into a binary format bound to the embedded computer and the operating system (OS) that the application runs on. As long as one obtains it from the computer, he/she can install it into the same hardware and the same operating system. The add-on value created by the developer is thus lost.

Moxa engineering force has developed this protection mechanism for your applications via data encryption. The binary file associated with each of your applications needs to undergo an additional encryption process after you have developed it. The process requires you to install an encryption key in the target computer.

1. Choose an encryption key (e.g.,"ABigKey") and install it in the target computer by a preutility program, 'setkey'.

   #setkey ABigKey

   Note: set an empty string to clear the encryption key in the target computer by:

   #setkey ""

2. Develop and compile your program in the development PC.
3. In the development PC, run the utility program 'binencryptor' to encrypt your program with an encryption key.

   #binencryptor yourProgram ABigKey

4. Upload the encrypted program file to the target computerby FTP or NFS and test the program.

The encryption key is a computer-wise key. That is to say, a computer has only one key installed. Running the program 'setkey' multiple times causes the key to be overrided.

To prove the effectiveness of this software protection mechanism, prepare a target computer that has not been installed an encryption key or install a key different from that used to encrypt your program. In any case, the encrypted program fails immediately.

This mechanism also allows the computer with an encryption key to bypass programs that are not encrypted. Therefore, in the development phase, you can develop your programs and test them in the target computer cleanly.

A

System Commands

Linux normal command utility collection

File manager

1.	**cp**	**copy file**
2.	**ls**	**list file**
3.	**ln**	**make symbolic link file**
4.	**mount**	**mount and check file system**
5.	**rm**	**delete file**
6.	**chmod**	**change file access permissions**
7.	**chown**	**change file owner**
8.	**chgrp**	**change file group**
9.	**sync**	**sync file system, let system file buffer be saved to hardware**
10.	**mv**	**move file**
11.	**pwd**	**display the current working directory**
12.	**df**	**list now file system space**
13.	**mkdir**	**make new directory**
14.	**rmdir**	**delete directory**

Editor

1.	**vi**	**text editor**
2.	**cat**	**dump file context**
3.	**zcat**	**compress or expand files**
4.	**grep**	**search string on file**
5.	**cut**	**get string on file**
6.	**find**	**find where the files are**
7.	**more**	**dump file by one page**
8.	**test**	**test file exist or not**
9.	**sleep**	**sleep (seconds)**
10.	**echo**	**echo string**

Network

1.	**ping**	**ping to test network**
2.	**route**	**routing table manager**
3.	**netstat**	**display network status**
4.	**ifconfig**	**set network ip address**
5.	**tracerout**	**trace route**
6.	**tftp**	**Trivial File Transfer Protocol client**
7.	**telnet**	**remote login utility**
8.	**ftp**	**File Transfer Protocol utility**

Process

1. **kill** **kill process**
2. **ps** **display now running process**

Other

1. **dmesg** **dump kernel log message**
2. **stty** **to set serial port**
3. **mknod** **make device node**
4. **free** **display system memory usage**
5. **date** **print or set the system date and time**
6. **env** **run a program in a modified environment**
7. **clear** **clear the terminal screen**
8. **reboot** **reboot / power off/on the server**
9. **halt** **halt the server**
10. **du** **estimate file space usage**
11. **gzip, gunzip** **compress or expand files**
12. **hostname** **show system's host name**

Moxa special utilities

1. **kversion** **show kernel version**
2. **upramdisk** **mount ramdisk**
3. **downramdisk** **unmount ramdisk**
4. **setinterface** **configure serial port mode as RS-232, RS-422, or RS-485**
5. **upgradehfm** **firmware upgrade utility**
6. **reportip** **UC Finder host program**
7. **setdef** **reset to default script**